Clinical Efficacy of Sterile Exsanguination Silicone Tourniquets on Primary Total Knee Arthroplasty

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Abstract

Objective

To compare the clinical efficacy on the accelerated recovery of postoperative patients in Primary TKA with pneumatic tourniquet and a sterile exsanguination silicone tourniquet.

Methods

In total 50 patients undergoing primary total knee arthroplasty were retrospectively studied from April to October in 2020. With the design of sequential trial, in total 25 patients (20 cases of single knee, 5 cases of double knee, a total of 30 knees) qualified were assigned to group sterile exsanguination silicone tourniquet from April to July; total 27 patients (24 cases of single knee, 3 cases of double knee, a total of 30 knees) were included into the group of pneumatic tourniquets. Intraoperative blood loss before releasing tourniquet, total blood loss, surgical time, tourniquet use time, allogeneic blood transfusion rates, incidence of deep venous thrombosis and knee active range of motion (ROM) were summarized. Visual clarity of surgical field, thigh pain and knee pain were measured by the Visual Analog Scale. Lovett muscle strength classification standard was adopted to evaluate quadriceps strength.

Results

Compared to pneumatic tourniquet, the sterile exsanguination silicone tourniquet group could obviously decrease the blood loss before releasing tourniquet ($P<0.001$). Meanwhile, the excellent visual clarity of surgery field could be acquired in sterile exsanguination silicone tourniquet group with Score ($P <0.001$). However, there is no significant difference in total blood loss between the two groups ($P =0.67$). In sterile exsanguination silicone tourniquet group, tourniquet use time (64.10±4.98) min, operation time (73.03±6.11) min, the incidence of deep vein thrombosis was 13.33%. In pneumatic tourniquet group, tourniquet use time (70.73±13.13) min, operation time (79.33± 14.57) min, the incidence of deep vein thrombosis was 36.67%. The difference between the two groups was statistically significant ($P=0.01$, $P=0.04$, $P=0.04$). In the postoperative early stage, the thigh VAS score, knee VAS score, quadriceps strength and knee active range of motion in sterile exsanguination silicone tourniquet group were much better than those in pneumatic tourniquet group. There was no significant difference for allogeneic blood transfusion rates and tramadol demand rate between groups.

Conclusion

A sterile exsanguination silicone tourniquet is an effective method to reduce intraoperative blood loss and provide much visual clarity of surgery field, which is beneficial to improve surgical efficiency and decrease tourniquet use time and and surgical time. In the postoperative early stage, compared to pneumatic tourniquet, sterile exsanguination silicone tourniquet could reduce the crush injury and thigh pain of tourniquet, improve quadriceps strength and knee active range of motion, which is beneficial to faster recovery for patient as well as increasing patient satisfactions.

Key words

Total knee arthroplasty; sterile exsanguination silicone tourniquet; pneumatic tourniquet

Total knee arthroplasty (TKA) is one of the most common operations on the knee joint. It is used to treat end-stage arthritis and other related knee joint diseases, which can quickly and effectively improve joint function and improve the quality of life of patients[1] . With the application of the concept of accelerated rehabilitation, clinical practice has gradually focused on surgical safety, recovery speed and patient satisfaction [2,3]. Tourniquets are widely used for intraoperative hemostasis and improvement of surgical vision, which can create a clean osteotomy surface environment, which is conducive to the fixation of bone surface-bone cement-prosthesis [4]. There are still some disadvantages in the use of Pneumatic tourniquets, such as thigh swelling, skin blisters, muscle atrophy,

nerve damage, deep vein thrombosis, which delays the recovery process and reduces patient satisfaction [5]. The fine management of the perioperative period puts forward higher requirements for the use of tourniquets. Whether tourniquet should be used in TKA, how tourniquet should be used, safety pressure and time limit are still controversial, and the impact on postoperative rehabilitation still needs further study.

The sterile exsanguination silicone tourniquet (produced in Israel) has a good exsanguination and tourniquet effect. As a new concept and technology, it has been widely used abroad in trauma orthopedics, knee arthroplasty, hand and foot surgery, limb vascular Surgery and neurosurgery [6, 7] , and has been gradually applied to the domestic orthopedics clinic.

This article retrospectively reviews patients who underwent first total knee arthroplasty in our hospital from April 2020 to October 2020 from the aspects of perioperative blood loss and surgical field clarity, postoperative pain, functional rehabilitation and complications. Analyze the clinical effects of Pneumatic tourniquet and sterile exsanguination silicone tourniquet to provide references for the selection and application of tourniquets in knee arthroplasty surgery.

1 Materials and methods

1.1 General information

A total of 52 patients were enrolled, including 7 males and 44 females; they were 50-75 years old. Divided into two groups according to the sequence study method, of which 25 cases (20 cases of one knee, 5 cases of double knees, a total of 30 knees) used sterile exsanguination silicone tourniquet, 27 cases (24 cases of one knee, 3 cases of double knees, A total of 30 knees) Use pneumatic tourniquet. There was no statistically significant difference in general information between the two groups before operation (P>0.05, see Table 1).

Inclusion criteria: (1) Age 50-75 years; (2) Unilateral total knee arthroplasty or bilateral knee arthroplasty for the first time, such as bilateral knee arthroplasty surgery, the same method of exsanguination and tourniquet was used for both operations, and the interval between two operations is 10 days.

Exclusion criteria: (1) history of knee surgery; (2) open trauma of lower extremities; (3) abnormal blood coagulation or long-term use of anticoagulant drugs, blood system diseases; (4) deep vein thrombosis of lower extremities, pulmonary embolism, cerebral embolism, Myocardial infarction, cerebral infarction, etc.; (5) Limb infection or malignant transformation or edema; (6) History of peripheral nerve and vascular disease; (7) Third-grade hypertension, which cannot be effectively controlled.

Table 1 Comparison of general information of the two groups of patients

Group	n	Number of TKA (cases)		Gender (cases)		Age (years)	BMI (kg/m^2)	HCT（%）	Preoperative hemoglobin (g/L)
		Bilateral	Unilateral	M	F				
Sterile elastic tourniquet	25	5	20	3	21	65.36±4.92	28.02±4.05	38.31±3.55	128.12±11.72
Pneumatic tourniquet	27	3	24	4	23	65.26±6.48	26.22±2.95	36.93±2.95	122.26±10.70
t value /X^2 value		0.79		0.11		0.06	1.55	1.53	1.88
P value		0.38		0.74		0.95	0.13	0.13	0.07

1.2 Surgical methods

All patients received the same perioperative treatment strategy: primary total knee arthroplasty, pain control and rehabilitation exercises. The operation was performed under general anesthesia under tracheal intubation and was completed by the same chief surgeon. The bone cement artificial joint prosthesis was used, the knee joint was approached centrally, and the patella was routinely preserved. For patients who need bilateral knee arthroplasty surgery, they usually perform rehabilitation exercises for 10 days after the surgery on one knee joint, and perform the surgery on the contralateral knee joint.

Multimodal analgesia was used: celecoxib (200 mg, Bid) was taken orally 2 days before surgery, and femoral nerve block (0.2% ropivacaine, 20 mL) was preoperatively guided by ultrasound. The application of hemostatic drug tranexamic acid: 30 minutes before cutting the skin, intravenous infusion of tranexamic acid 1.0g (0.25g/5mL); when the joint capsule is sutured, the joint cavity is infused with tranexamic acid solution (tranexamic acid 1.0 g + Ropivacaine 20mL+Methylprednisolone sodium succinate 40mg for injection, diluted with normal saline for a total of 100mL); while closing the incision, intravenous infusion of tranexamic acid 1.0 g. Antibacterial drugs were routinely given to prevent infection.

In the exsanguination silicone tourniquet group, the model and specification of the silicone tourniquet should be selected according to the patient's blood pressure, the length of the affected limb (the length from the toe or finger to the placement), and the limb circumference of the placement before the operation. After disinfection and draping, open the double-layer sterile packaging (ethylene oxide sterilization), take out the sterile exsanguination silicone tourniquet, put it in from the toe, pulling the rope slowly upwards along the direction of the limb to the placement (near the groin). In the pneumatic tourniquet group, the pneumatic tourniquet is tied to the upper 1/3 of the thigh. Before the tourniquet is inflated, raise the affected limb or use an elastic bandage to exsanguination. The tourniquet pressure is 280~300mmHg, and the cuff width is about 11cm. In all operations, the intraoperative systolic blood pressure is controlled at 100~120mmHg, and the average arterial pressure is 70~80mmHg. The tourniquet was applied before the skin incision. After the joint capsule was sutured and the joint cavity was infused with tranexamic acid solution, the tourniquet was released and sutured layer by layer to close the incision. The drainage tube was placed according to the clinical situation, and the elastic bandage was used to compress the foot to the thigh after the operation.

1.3 Postoperative treatment

Postoperative ECG monitoring, oxygen inhalation for 6 hours, air pressure adjuvant therapy on both sides of the calf, anticoagulant therapy was started 6-8 hours postoperatively, and antibiotics were given to prevent infection within 24 hours postoperatively. Self-controlled analgesia pump (100mL, drip rate 2mL/h) was used in the first 2 days after surgery, and intravenous or oral non-steroidal drugs and weak opioids were continuously administered for analgesia until discharge. Daily local physical cooling of the wound, infrared therapy, quadriceps isometric contraction exercise, ankle dorsiflexion and toe flexion exercises. On the second day after the operation, they started walking exercises with weight-bearing activities, as well as knee extension and knee bending exercises with full joint range of motion.

1.4 Evaluation Index

The basic data of all patients, such as gender, age, body mass index (BMI), were recorded. According to the weight change of the gauze piece during the operation and the volume change of the flushing bottle, the apparent blood loss was calculated. Detect the hemoglobin level and hematocrit of the patients before and after the operation, and calculate the red blood cell volume and total blood loss according to the Gross[8] linear equation and the Nadler formula[9].

Main indicators: Record intraoperative blood loss before the tourniquet relaxes, total blood loss, intraoperative visual field clarity VAS score [10], tourniquet use time and operation time.

Secondary indicators: (1) The visual analogue scale (VAS) was used to evaluate the muscle pain and knee joint pain at the tourniquet area; (2) The Lovett muscle strength grading standard was used to evaluate the postoperative muscle strength; (3) The patient was in Measure the range of motion (ROM) of knee joint in the supine position;

(4) Other indicators, such as the incidence of deep vein thrombosis, the demand of weak opioid (tramadol) and blood transfusion; (5) Record complications Such as skin damage at tourniquet site, swelling, nerve damage, incision swelling, incidence of infection, etc.

VAS score of Clarity (full score 10 points, 1 point poor field of view, 10 points best field of view), the scoring rules are as follows:

1-2 points: bleeding during skin incision, obvious bleeding throughout the operation; 3-4 points: significant blood oozing in the tissue, significant blood accumulation in the joint cavity; 5-6 points: tissue oozing blood, slight blood accumulation in the joint cavity, fuzzy and difficult to distinguish the structure of tissues such as muscle and fat; 7-8 points: blood in the joint cavity but no blood accumulation, tissue structure such as muscle and fat are visible, and blood oozing on the osteotomy surface; 9-10 points: no obvious bleeding during the whole operation. The tissue structure such as muscle and fat is clear and identifiable, and the osteotomy surface is clean.

1.5 Statistical processing

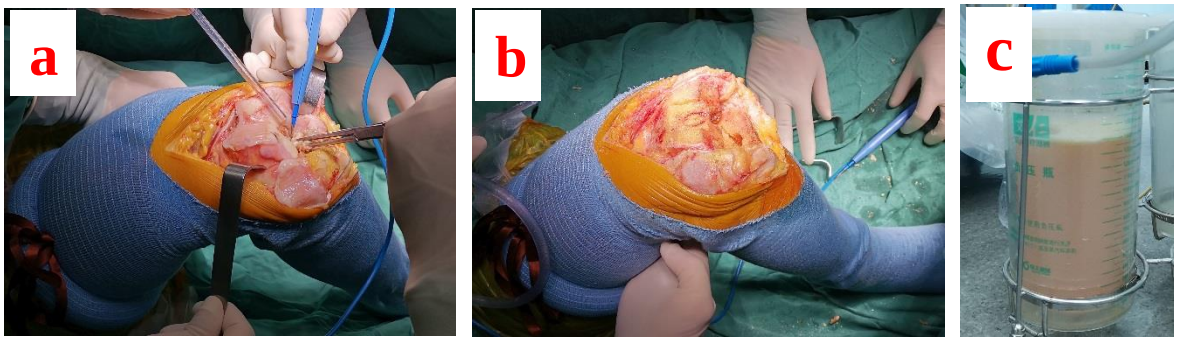
SPSS 21.0 software was used for statistical analysis. Measurement data were expressed as ($\bar{x}\pm s$), and independent sample Student's-t test was used; count data was expressed by rate, and X^2 test was selected. $P<0.05$ is considered statistically significant.

2 Results

2.1 Intraoperative application of tourniquet

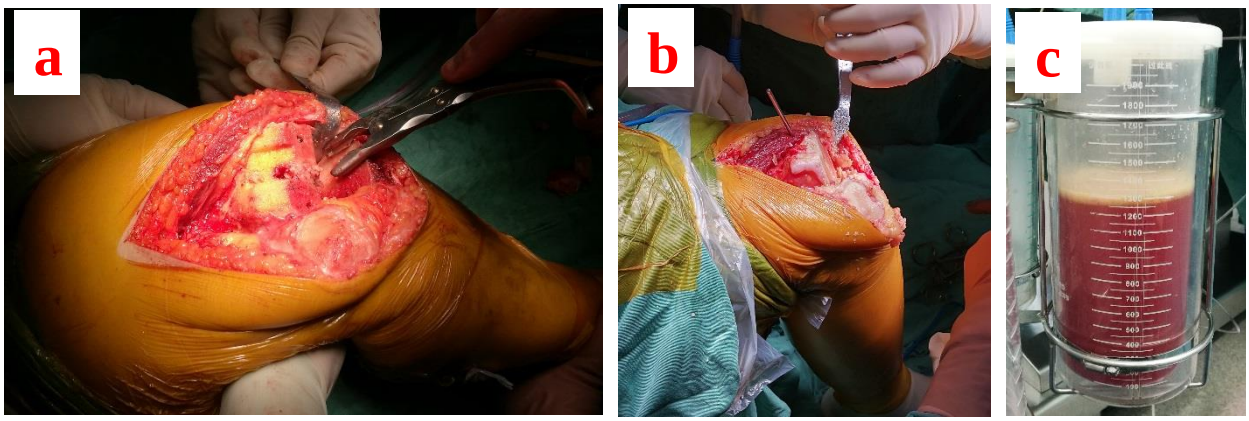
There were 25 cases (30 knees) in the sterile exsanguination silicone tourniquet group. The models were Large Orange 3 knees, Large Brown 5 knees, and X-Large black & white 22 knees (see Figure 1).

In the Pneumatic tourniquet group, there were 27 cases (30 knees). Because of its wide cuff and narrow operation area, the movement of the limbs is limited during the operation, and blood stains in the incision tissue are obvious (see Figure 2).



a) Open the joint capsule b) Osteotomy surface before flushing c) Flushing fluid after installing the prosthesis

Figure 1. Intraoperative situation with the use of sterile exsanguination silicone tourniquet



a) Open the joint capsule b) Osteotomy surface before flushing c) Flushing fluid after installing the prosthesis

Figure 2. Intraoperative situation with pneumatic tourniquet

2.2 Blood loss and clarity of vision

The statistical results of operation time, tourniquet usage time, intraoperative blood loss before tourniquet relaxation, total blood loss and hemoglobin reduction are shown in Table 2. In the exsanguination silicone tourniquet group, the application time of the tourniquet was (64.10±4.98) min, and the operation time was (73.03±6.11) min. These two indexes were significantly less than those of the pneumatic tourniquet group (the application time of the tourniquet was (70.73±13.13) min (P=0.01), the operation time was (79.33±14.57) min (P=0.04)).The intraoperative visual field clarity VAS score was (8.90±6.11) points in the exsanguination silicone tourniquet group, which was better than the Pneumatic tourniquet group (7.27±0.78) points (P<0.01). Comparing the blood loss before the tourniquet was released, the blood loss of the exsanguination silicone tourniquet group was (15.27±6.75) mL, which was significantly lower than that of the pneumatic tourniquet group (76.48±9.53) mL, P<0.01. There was no significant difference in the total blood loss, the hemoglobin level on the first and the third day after the operation, and the maximum reduction of hemoglobin between the two groups.

Table 2 Intraoperative clarity and blood loss

Group	Tourniquet time (min)	Operation time (min)	Surgical field clarity VAS score (points)	Blood loss before releasing the tourniquet (mL)	Hemoglobin on 1st day post-op (g/L)	Hemoglobin on 3rd day post-op (g/L)	Maximum hemoglobin reduction (g/L)	Total blood loss (mL)
Sterile elastic tourniquet	64.10±4.98	73.03±6.11	8.90±0.66	15.27±6.75	110.53±12.51	100.87±10.52	23.70±9.20	752.59±333.01
Pneumatic tourniquet	70.73±13.13	79.33±14.57	7.27±0.78	76.48±22.10	107.87±10.87	98.37±11.19	22.30±9.53	788.98±329.98
t value /X^2 value	-2.59	-2.18	8.71	-14.51	0.88	0.89	0.58	-0.43
P value	0.01	0.04	<0.01	<0.01	0.38	0.38	0.57	0.67

2.3 Pain score

2.3.1 Muscle pain score at the site of hemostasis

VAS scores were used to evaluate the muscle pain at the hemostatic site on the 1st, 2nd, 3rd, 5th day after operation and at the time of discharge. In the first 3 days after the operation, the thigh pain score of the hemostatic site in the exsanguination silicone tourniquet group was lower than that in the Pneumatic tourniquet group, and the difference was statistically significant (see Table 3).

Table 3 Comparison of the VAS scores of thigh muscle pain at the hemostatic site between the two groups（ $\bar{x}$±s , points）

Group	1st day post-op	2nd day post-op	3rd day post-op	5th day post-op	On discharge
Sterile elastic tourniquet	2.23±0.73	1.73±0.58	1.23±0.77	1.03±0.76	0.73±0.83
Pneumatic tourniquet	2.70±0.70	2.03±0.49	1.63±0.72	1.10±0.40	0.73±0.78
t value	-2.53	-2.16	-2.08	-0.42	0.00

P value	0.01	0.04	0.04	0.68	1.00

2.3.2 Knee pain score

In the first 3 days after operation, the pain VAS score of the exsanguination silicone tourniquet group was better than that of the Pneumatic tourniquet group, and the difference was statistically significant (see Table 4).

Table 4 Comparison of the VAS scores of knee joint pain between the two groups（ $\bar{x}\pm s$, points）

Group	1st day post-op	2nd day post-op	3rd day post-op	5th day post-op	On discharge
Sterile elastic tourniquet	4.17±0.70	3.67±0.80	2.83±0.53	2.34±0.48	2.20±0.41
Pneumatic tourniquet	4.67±0.92	4.10±0.76	3.27±0.87	2.53±0.57	2.30±0.47
t value	-2.37	-2.15	-2.33	-1.37	-0.89
P value	0.02	0.04	0.02	0.18	0.38

2.4 Quadriceps muscle strength score

The Lovett score was used to evaluate quadriceps muscle strength. The quadriceps muscle strength scores in the exsanguination silicone tourniquet group were better than the Pneumatic tourniquet group in the first 3 days after operation, and the difference was statistically significant (see Table 5).

Table 5 Comparison of Lovett muscle strength scores between the two groups（ $\bar{x}\pm s$, points）

Group	1st day post-op	2nd day post-op	3rd day post-op	5th day post-op	On discharge
Sterile elastic tourniquet	2.53±0.63	2.97±0.61	3.60±0.50	4.31±0.47	4.80±0.41
Pneumatic tourniquet	2.07±0.78	2.57±0.57	3.30±0.53	4.17±0.46	4.57±0.50
t value	2.54	2.60	2.25	1.18	1.97
P value	0.01	0.01	0.03	0.24	0.05

2.5 Knee joint range of motion

The patient was in the supine position, and the long-arm goniometer was used to measure the range of motion of the knee joint. In the first 3 days after the operation, the performance of the range of motion of the knee joint in the exsanguination silicone tourniquet group was better than that in the pneumatic tourniquet group (see Table 6).

Table 6 Comparison of knee joint range of motion between the two groups（ $\bar{x}\pm s$, °）

Group	1st day post-op	2nd day post-op	3rd day post-op	5th day post-op	On discharge
Sterile elastic tourniquet	65.53±18.47	76.30±18.54	84.67±18.29	92.76±13.13	99.73±10.05
Pneumatic tourniquet	57.07±10.50	68.27±10.14	77.03±8.07	89.27±11.25	97.50±9.04
t value	2.18	2.08	2.09	1.10	0.91
P value	0.03	0.04	0.04	0.28	0.37

2.6 Postoperative complications

The incisions healed well in all patients, no infection and loosening of the prosthesis were found, and no skin damage was found at the hemostatic site. As the patient got out of bed, the affected limb often showed slight swelling, and no malignant swelling was found. The results of arteriovenous ultrasound of both lower extremities showed that deep vein thrombosis of lower extremity was mostly muscular calf vein thrombosis (MCVT). The incidence of exsanguination silicone tourniquet group was significantly lower than that of Pneumatic tourniquet group (P=0.04, see Table 7).

Table 7 Comparison of clinical indicators between the two groups [Example (%)]

Group	Intermuscular vein thrombosis	Postoperative blood transfusion	The need for tramadol after surgery
Sterile elastic tourniquet	4（13.33）	1（3.33）	9（30.00）
Pneumatic tourniquet	11（36.67）	1（3.33）	11（36.67）
X^2 value	2.80	0.00	0.30
P value	0.04	1.00	0.58

3 Discussion

The optimized application of tourniquet in TKA is an important part of perioperative management. As a new type of tourniquet, the sterile exsanguination silicone tourniquet has excellent exsanguination and hemostatic performance, and has a variety of models and specifications, which can meet the clinical needs of the personalized application of tourniquet. This article compares the clinical effects of Pneumatic tourniquet and exsanguination silicone tourniquet from the aspects of perioperative exsanguination and hemostatic performance, surgical field clarity, functional rehabilitation, complications, and provides strategies for the selection and optimization of tourniquets in TKA.

In terms of the clarity of the visual field during the operation, the joint capsule was opened during the operation of the exsanguination silicone tourniquet group, the worn cartilage is clearly visible, the muscle and fat tissue is dry, no blood stains, the osteotomy surface is dry during the operation, and there is no blood exudation, the blood color of the drainage bottle after the operation is lighter, and the blood loss is less throughout the operation. In the Pneumatic tourniquet group, the osteotomy surface oozes blood, the operation space is narrow and the tissue around the joint capsule is full of blood stains, the blood of the drainage bottle after the operation is darker, and there is more blood loss throughout the operation. From the intraoperative photos, it can be seen directly that the exsanguination and hemostatic performance of the exsanguination silicone tourniquet group is better than that of the Pneumatic tourniquet group. In this study, the VAS score was used to evaluate the clarity of the visual field during the operation of the two groups. The exsanguination silicone tourniquet group was better than the Pneumatic tourniquet group and the difference was statistically significant. The exsanguination silicone tourniquet has good exsanguination and hemostatic performance, and can provide a good operating environment for the surgeon. In order to further investigate the performance of exsanguination and hemostatic, we statistically analyzed the amount of blood loss before the intraoperative tourniquet was released. The exsanguination silicone tourniquet group was significantly less than the Pneumatic tourniquet group, and the difference was statistically significant, which can significantly reduce the intraoperative blood loss , which is helpful for intraoperative blood management. Blond et al. [11] thought that when elastic bandage or raising the affected limb to expel blood, the maximum amount of expelling blood was about 67%. Demirakale et al. [12] studies have shown that in TKA, The amount of blood expelled by the exsanguination silicone tourniquet reached 95%, which can reduce the blood transfusion rate and blood loss. In this study, the difference in total blood loss and blood transfusion rate between the two groups was not statistically significant, which may be related to the timing of the release of the tourniquet during surgery.

In terms of operation time, although it mainly relies on the surgeon's surgical skills, a good surgical field of vision can also help to improve the efficiency of the operation and save operation time [13, 14]. This study investigated

the use time of the tourniquet and the operation time, and the results showed that the exsanguination silicone tourniquet group was better than the Pneumatic tourniquet group, and the difference was statistically significant. The use of tourniquet has a certain impact on postoperative rehabilitation. It directly or indirectly affects the soft tissues of the lower limbs, such as nerves, blood vessels and muscles. And it ultimately affects the functional recovery of the affected limbs. Among them, pain is one of the common symptoms after TKA, the skin and deep tissues can be squeezed to cause limb pain, and tourniquet-induced ischemia/reperfusion injury, which will aggravate limb pain and swelling. Liao Yunjian et al. [15] showed that the duration of tourniquet compression is the determinant of the degree of muscle and soft tissue damage, rather than ischemia-reperfusion injury. The results of this study showed that the VAS score of thigh pain at the tourniquet site in the first 3 days after the operation of the exsanguination silicone tourniquet group was significantly lower than that of the Pneumatic tourniquet group, and the difference was statistically significant. Demirakale et al. [12] showed that in terms of the incidence of pain and analgesia requirements after TKA, the exsanguination silicone tourniquet is better than the Pneumatic tourniquet. The wider the tourniquet cuff and the higher the pressure, the more the tourniquet damages the limbs and the more significant the pain [16, 17]. The wider the cuff can easily cause myofascial deformation and cause pain. The narrow exsanguination silicone tourniquet can be worn to the groin, which can reduce the squeeze of the myofascial membrane, thereby reducing pain.

The damage of the tourniquet to the soft tissues of the lower limbs is also manifested as an impact on the function of the quadriceps muscle, which will affect the early recovery after the operation. The influence of tourniquet on postoperative muscle strength has not yet been reached a consistent conclusion. Studies have shown that within 3 months after TKA, the quadriceps muscle strength of the group without tourniquet is better than that of the group with tourniquet [18]. However, Sun Xiao et al. [19] measured quadriceps muscle strength by muscle strength level, and did not find that the use of tourniquets would have an effect on muscle strength after TKA. In this study, the Lovett muscle strength score was used to measure the strength of the quadriceps muscle. The results showed that the quadriceps muscle strength of the exsanguination silicone tourniquet group was better than the pneumatic tourniquet group on the first 1, 2 and 3 days after the operation, and the difference was statistically significant. In TKA surgery, the weakening of quadriceps muscle strength is multifactorial, which may be due to direct compression injury of the tourniquet or ischemia/reperfusion [14, 20]. The recovery of quadriceps muscle strength after surgery is conducive to the early recovery of knee joint function after surgery, and can also be used as an index to predict long-term joint function. In the early postoperative period, the mobility of the knee joint in the exsanguination silicone tourniquet group was better than that in the Pneumatic group, which was closely related to the quadriceps muscle strength after the operation. In the first month after surgery, the tourniquet has a greater impact on the range of motion of the knee joint, but it cannot affect the long-term range of motion of the knee joint after the operation [21].

With the popularization of the concept of accelerated rehabilitation and everyone's attention to the prevention of venous thrombosis after orthopedic surgery, the current incidence of deep vein thrombosis in the lower extremities after TKA has been greatly reduced, and the incidence of symptomatic deep vein thrombosis in the lower extremities is 3.36% [22]. In this study, the incidence of muscular calf vein thrombosis in the exsanguination silicone tourniquet group was significantly lower than that in the Pneumatic tourniquet group ($p<0.05$). Any cause of venous injury, venous blood flow stagnation, and hypercoagulable state of blood are risk factors for venous thromboembolism. TKA surgery does not completely expel blood, which can easily cause blood stasis in the lower limbs, which can induce thrombosis [11]. When the traditional elastic bandage is used to expel blood, the blood is not completely expelled and the blood is stagnant. At the same time, the calf gastrocnemius muscle is squeezed unevenly by the expelling bandage, which causes venous damage and further aggravates the formation of thrombosis in the lower limbs. The exsanguination silicone tourniquet has a better hemostatic effect, and there is less residual blood in the lower limbs, which is not easy to cause blood stasis, thereby reducing the incidence of thrombosis. This study is consistent with the report of Demirakale et al. [12] that the exsanguination silicone

tourniquet can reduce the incidence of thrombosis after TKA.

In terms of preventing infection, this study did not find any cases of infection. However, studies have shown [12, 23] that the exsanguination silicone tourniquet can reduce the infection rate after TKA. The possible reason is that the exsanguination silicone tourniquet is a sterile product (ethylene oxide disinfection), and the Pneumatic tourniquet is non-sterile, and can be used repeatedly. Thompson et al. [24] and other studies have shown that the Pneumatic tourniquet has microbial colonization, and bacteria can easily reach the wound through the sterile textile, increasing the risk of infection.

In total knee arthroplasty surgery, compared with the Pneumatic tourniquet, the exsanguination silicone tourniquet is more adequate to dispel blood, which can obtain a clear surgical field of vision, reduce blood loss, improve surgical efficiency, and shorten surgical time. In the early postoperative period, the exsanguination silicone tourniquet can reduce the crushing injury to the limbs, reduce the pain of the thigh, help the recovery of quadriceps muscle strength and knee joint mobility, accelerate the rehabilitation of patients, and improve patient satisfaction. The shortcomings of this study are that it is only limited to the follow-up of patients during hospitalization, and the lack of long-term follow-up data after surgery , which needs further study..

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