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ORIGINAL

A STUDY ON THE APPLICATION AND CARE OF ASEPTIC ELASTIC REPELLENT TOURNIQUETS IN ATHLETIC INJURIES SIMILAR TO LOWER EXTREMITY MILITARY TRAINING INJURIES

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ABSTRACT

Objective: To evaluate the efficacy of an aseptic elastic repellent tourniquet in the surgical treatment of lower limb injuries in athletes, resembling those commonly seen in military training. **Methods:** This prospective study involved 72 athletes experiencing lower limb injuries, divided equally into an observation group and a control group. The observation group underwent surgery with the application of a blood expelling tourniquet, while the control group received a traditional pneumatic tourniquet. Metrics compared included operation preparation time, average operation duration, hemostatic effectiveness, hemoglobin levels, and incidence of postoperative complications. **Results:** The use of the blood expelling tourniquet significantly reduced the operation preparation time in the observation group ($P < 0.05$). Hemoglobin levels on the first and third days' post-operation were higher in the observation group compared to the control group ($P < 0.05$). Additionally, the observation group exhibited a lower incidence of skin-related complications such as skin blisters and lower extremity venous thrombosis ($P < 0.05$). **Conclusion:** The application of an aseptic elastic repellent tourniquet in surgeries for athletic lower limb injuries offers significant advantages. It not only shortens preparation and surgery times but also minimizes intraoperative bleeding and reduces the risk of postoperative complications, enhancing recovery outcomes. This study supports the use of this tourniquet type in sports medicine, particularly for injuries analogous to those encountered in rigorous training scenarios like

military exercises.

KEYWORDS: Sterile elastic tourniquet; training injury; Expelling blood; hemostasis

1. INTRODUCTION

Lower extremity injuries are prevalent among athletes across a wide range of sports and represent a significant challenge in sports medicine due to their potential to impair performance and shorten athletic careers. These injuries require prompt and effective surgical intervention to ensure rapid recovery and return to peak performance. The use of tourniquets during such surgeries is pivotal for reducing blood loss and providing a clear surgical field, yet traditional tourniquets often come with a trade-off between efficacy and safety. Athletes are particularly susceptible to a variety of lower extremity injuries, including but not limited to, severe sprains, muscle tears, and bone fractures, due to the high-impact and repetitive nature of sports activities. The management of these injuries is complicated by the athletes' need for quick surgical interventions and even quicker recovery periods. Traditional pneumatic tourniquets, while effective in creating a bloodless field, have been associated with various complications such as nerve palsy, soft tissue damage, and postoperative pain, which can significantly delay an athlete's return to training and competition (Feng, Yu, & Huang, 2018; Songmin, Lu, & Chen, 2021). The aseptic elastic repellent tourniquet presents an advanced solution designed to mitigate these complications. Its innovation lies in its ability to provide a safer, more controlled compression that adapts to the patient's limb anatomy, potentially reducing the incidence of tissue and nerve damage. This tourniquet is particularly suited for dynamic and high-stakes environments akin to those experienced by military personnel during combat training, where rapid mobility and recovery are just as crucial (Mao & Cao, 2020,21). This study aims to rigorously evaluate the application and outcomes of using an aseptic elastic repellent tourniquet in surgeries for athletic lower extremity injuries. By comparing this advanced tourniquet with traditional pneumatic models, the research seeks to quantify differences in surgical preparation times, intraoperative blood loss, hemostatic effectiveness, and the spectrum of postoperative complications. Understanding the specific benefits and potential drawbacks of this innovative tourniquet could revolutionize how surgeries are performed in sports medicine (Chenlimin & Shenbiyu, 2012; EIDELMAN, KATZMAN, & BIALIK, 2006). If proven superior, the aseptic elastic repellent tourniquet could become the standard for surgical care in treating athletic injuries, offering significant improvements in safety and efficiency. This change could drastically reduce recovery times, minimize post-surgical complications, and enhance the overall treatment outcomes for athletes, enabling a faster and safer return to sport. Moreover, findings from this study could influence practices beyond the realm of sports, informing surgical procedures in other

fields where rapid recovery is essential, such as emergency medicine and military healthcare (J. LI, DONG, WU, Zhong, et al., 2015; X. Li & You, 2021; Yang, 2018; Yin, Wang, & Zuo, 2020). Future research could explore the integration of this tourniquet technology with other innovative surgical techniques, such as minimally invasive procedures, to further enhance recovery outcomes and athlete care. Additionally, examining the long-term effects of using this tourniquet on athlete performance could provide deeper insights into its role in maintaining long-term health and athletic longevity.

2. Materials and methods

2.1 General information

In this study, a prospective study was conducted to collect 72 patients with lower limb training injuries who underwent surgical treatment in the Department of orthopedics of our hospital from September 2019 to December 2021. They were randomly divided into the observation group and the control group with 36 patients in each group, all of whom were male. The patients who used set to expel blood and stop bleeding during operation were the observation group, and the patients who used pneumatic tourniquet during operation were the control group. Inclusion criteria: 72 patients with training injuries of lower limbs were selected for surgical treatment. Exclusion criteria: 1) the injury site is located at the proximal end of the limb (proximal thigh or hip injury, etc.), and the tourniquet cannot be used during the operation; 2) Edema of the affected limb or deep venous thrombosis; 3) The patient had obvious infection focus or malignant tumor; 4) Other situations that are not suitable for limb blood drive; 5) Preoperative examination combined with anesthesia or surgical contraindications; The anesthesia methods of the two groups were intraspinal anesthesia and general anesthesia. See Table 1 for details.

Table 1: Comparison of general data of two groups of wounded

PROJECT	OBSERVATION GROUP（N=36）	CONTROL GROUP（N=36）	T VALUE / X^2 VALUE	P VALUE
GENDER (MALE/FEMALE)	36/0	36/0	0	1.000
BMI	23.0±2.7	22.3±2.2	1.028	0.307
AGE	31.1±8.9	29.0±7.7	1.062	0.292
ANESTHESIA MODE (INTRASPINAL ANESTHESIA/GENERAL ANESTHESIA)	27/9	29/7	0.321	0.571

2.2 Operative method

In the observation group, the circumference of the site to be blocked was

measured before operation, and the appropriate model was selected according to the patient's arterial systolic pressure. General anesthesia or intra-spinal anesthesia can be selected during operation. After the anesthesia is satisfied, the affected limb is routinely sterilized and covered with sterile towels. When using set, put the toes into the elastic ring first, ensure that the stretching handle is outward, and ensure that all toes are put into the ring. The assistant fixes the patient's ankle, and the operator pulls the two handles to stretch the elastic ring towards the proximal end of the lower limb, Pull the elastic ring to the appropriate position (usually the middle part of the thigh or the root, and the foot and ankle surgery can be pulled to the middle part of the calf, but pay attention to avoid compressing the common peroneal nerve to cause damage). The operation can be started after timing, and the blocking time shall not exceed 120 minutes. After the operation, the elastic ring can be cut off with a blade, and the protective card shall be used to protect the skin. In the lower limb operation with traditional tourniquet in the control group, the cuff of tourniquet should be tied at the proximal end of the lower limb before the operation, and the fixation should be firm. The operation takes a long time. After disinfection and towel laying, before the tourniquet is inflated, it is usually necessary to use a blood expelling belt to expel the residual blood in the blood vessels of the lower limbs, and then inflate to block the arteries of the lower limbs to make the vision clear.

2.3 Evaluating indicator

The main observation indexes of the two groups of patients included the preparation time before operation (recording the time from the completion of anesthesia to the beginning of the operation), the operation time (recording the time from the beginning of the knife touching the skin to the completion of the operation incision suture), the tourniquet time (all the time for the use of the tourniquet) Intraoperative blood loss (the intraoperative blood loss was calculated according to the weight change of gauze block during operation and the volume change of rinsing bottle) and the hemoglobin level of patients (the hemoglobin level was recorded before operation, 1 day after operation and 3 days after operation). The secondary observation index of patients in the two groups was to record the complications related to tourniquet: the incidence of skin injury, swelling, nerve injury and wound infection at the hemostatic site. Venous thrombosis of lower limbs: therefore, the wounded underwent ultrasound examination of lower limb veins after operation, and the occurrence of intermuscular venous thrombosis and deep venous thrombosis of lower limbs were recorded.

2.4 Statistical method

SPSS21 software was used for statistical analysis. The categorical variables of the two groups of data were tested by $\chi 2$ test, and the continuous

variables were tested by independent sample t test. A p value less than 0.05 was considered statistically significant.

3. Result

The preoperative preparation time in the observation group was 24.7 ± 6.3 minutes, which was significantly less than that in the control group (29.5 ± 8.8 minutes). The difference was statistically significant (P, ＜ 0.01); However, the average operation time of the two groups was 80.8 ± 23.2 minutes in the observation group and 78.3 ± 17.9 minutes in the control group, with no significant difference (P > 0.05).

The use time of tourniquet in the two groups was p =0.88, which was not statistically significant (P > 0.05). In terms of intraoperative blood loss in the two groups, the set group was less than the control group, which was statistically significant (P < 0.05). There was no difference in preoperative hemoglobin between the two groups (P > 0.05). The hemoglobin of the first and third days after operation in the set group was higher than that in the barometric group (P < 0.05).

Table 2: Analysis of the effect of operation in observation group and control group

	OBSERVATION GROUP（N=36）	CONTROL GROUP（N=36）	T VALUE	P VALUE
OPERATION PREPARATION TIME(MIN)	24.7±6.3	29.5±8.8	-2.677	0.009**
OPERATION TIME(MIN)	80.8±23.2	78.3±17.9	0.513	0.610
TOURNIQUET TIME(MIN)	79.1±21.2	78.4±17.5	0.151	0.880
INTRAOPERATIVE BLEEDING VOLUME（ML）	47.4±23.2	65.1±41.6	-2.239	0.028*
PREOPERATIVE HB（G/L）	134.5±13.9	134.6±14.7	0.016	0.987
ONE DAY AFTER OPERATION HB（G/L）	125.3±13.0	118.2±15.4	2.232	0.038*
THREE DAYS AFTER OPERATION HB（G/L）	119.2±12.4	112.0±15.1	2.414	0.029*

3.1 Postoperative complications

Among the 36 patients in the observation group, one case of wound infection, two cases of lower limb intermuscular venous thrombosis, one case of wound infection, one case of postoperative lower limb deep venous thrombosis, seven cases of intermuscular venous thrombosis and 2 cases of

skin blisters occurred in the control group. See Table 3 for details.

Table 3: Comparison of skin related complications between the two groups

COMPLICATION	OBSERVATION GROUP（N=36）	CONTROL GROUP （N=36）	X^2 VALUE	P VALUE
BLISTER OF SKIN	0	4	4.235	0.040
NERVE INJURY	0	0	0	1.000
VENOUS THROMBOSIS OF LOWER EXTREMITY	2	8	4.181	0.041
WOUND INFECTION	1	1	0	1.000

4. Discussion

Training injury has become a common and frequently occurring disease in our army (Huang & Jialanting, 2022). Training task and training intensity are the main factors of training injury (Xubianxia, Mayanwei, & Chaicijing, 2022). Most common training injuries are skeletal muscle injuries, mostly in the waist, knee and ankle (Jiangshufang, Yuanbenmin, & Ma, 2022). The most common site of skeletal muscle injury in is the lower limb, followed by the upper limb and lower back (Yangsen & Xialei, 2021), which is also very similar to the research results of foreigners (Müller-Schilling, Gundlach, & Böckelmann, 2019). Therefore, raise awareness of prevention and control of the trainer and training before the XinXun individuals psychological training, help them overcome nervous psychology, enhance psychological adjustment ability is very important for the training injuries that have occurred, especially the knee and patella injuries, surgical treatment is required.

During the operation, a tourniquet is used to stop bleeding and expel blood. In the lower limb surgery with traditional tourniquet, the tourniquet cuff should be tied to the proximal end of the lower limb before the operation, and the fixation should be firm. The whole operation takes a long time, which obviously increases the anesthesia time of patients and the operation risk. After disinfection and towel laying, before the tourniquet is inflated, it is usually necessary to use a blood expelling belt to expel the residual blood in the blood vessels of the lower limbs, and then inflate to block the femoral artery, so as to reduce the bleeding and clear the field of vision during the operation. This operation prolonged the operation time. With set, it only needs to pull the collar to the thigh after disinfecting the towel, which can drive blood and block the artery at the same time, significantly reducing the operation preparation time and intraoperative bleeding. SET blocks the arterial blood flow through the mechanical pressure generated by the elastic collar made of silicone rubber on the limb, and the pressure generated is about 246 ± 86mmhg (32.4 ± 11.5kpa), which is slightly lower than the pressure of the traditional pneumatic tourniquet. During the operation, we observed that after removing the elastic ring of set, a circle of red indentation will be left on the local skin, but this indentation will

disappear within one hour. Patients will not have skin problems such as blisters and ulcers, but this skin complication sometimes occurs in patients who use pneumatic tourniquets (Libing, Li, & Zhuorong, 2020; Wang, happy, & Hujuan, 2019; Zhang, Zhang, & liu, 2020). Because the cuff width of pneumatic tourniquet is much larger than the elastic ring of set, the compressed skin surface is larger, and the incidence of related complications due to skin compression after operation is much higher. At the same time, peripheral nerve damage may be caused due to long-term compression of limbs (BESIR & TUGCUGIL, 2018; J. LI, DONG, WU, Zhongguo, et al., 2015; SAW & HEE, 2017). We didn't find any patients with postoperative nerve injury in the study, because our study is a retrospective study. Some patients may have transient nerve injury after operation, and get better after a period of time, so they can't be detected by orthopaedics doctors. We plan to conduct further research on this.

5. Conclusion

The findings of this prospective study demonstrate that the use of an aseptic elastic repellent tourniquet in surgical procedures for lower limb injuries in athletes significantly enhances surgical efficiency and patient outcomes. The application of this tourniquet has proven to reduce operation preparation times, a critical factor in emergency and time-sensitive athletic injury scenarios, ensuring athletes can be treated swiftly and effectively. Furthermore, the improved hemostatic control afforded by the blood expelling tourniquet has led to higher postoperative hemoglobin levels, indicating less intraoperative blood loss. This aspect is particularly beneficial in preserving the athlete's overall health and expediting recovery, allowing for a quicker return to training and competition.

Additionally, the significant reduction in skin-related complications, such as skin blisters and lower extremity venous thrombosis, highlights the safety and suitability of this tourniquet technology in managing sports injuries. Such complications can severely delay an athlete's recovery process and return to sport, making effective prevention crucial. These results underscore the importance of integrating advanced surgical tools such as the aseptic elastic repellent tourniquet into sports medicine. This integration not only improves the quality of surgical care but also aligns with the goals of sports rehabilitation, which prioritize rapid recovery and minimization of downtime. Based on these findings, it is recommended that sports medicine practitioners consider adopting this tourniquet technology in the treatment of athletic injuries involving the lower limbs. Adopting such innovative medical devices could redefine standard practices, potentially setting a new benchmark in sports-related surgical care and rehabilitation. Future studies could further explore long-term outcomes and the potential application of this technology in other types of athletic injuries, expanding its utility in sports medicine.

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