

Research Advances in the Risk Factors of Venous Thromboembolism after Knee Arthroscopy

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ABSTRACT

Knee arthroscopy, as a minimally invasive surgical procedure, is widely used in clinical practice and has become an ideal method for treating knee joint diseases. However, the risk of postoperative complications, especially venous thromboembolism (VTE), is relatively high, which seriously affects patients' postoperative recovery. In recent years, the risk factors for VTE after knee arthroscopy have attracted attention. This is of great significance for medical staff to further improve surgical techniques, preoperative preparation, and postoperative monitoring to ensure the effectiveness and safety of surgery. Based on the review of relevant literature, this study provides a comprehensive review of the overview of VTE and the new progress in the risk factors of VTE after knee arthroscopy, aiming to provide important reference for the rational formulation and implementation of prevention strategies for VTE after knee arthroscopy.

KEYWORDS

Knee arthroscopy; Postoperative venous thrombosis; Risk factors; Research advances

The knee joint is the largest and most complex weight-bearing joint in the human body, playing an important role in walking and movement. However, it is prone to related diseases under the influence of obesity, chronic overuse, trauma, and other diseases, which can damage the structure of the knee joint and lead to functional impairment, thereby reducing the quality of life of patients. With the continuous improvement of minimally invasive surgery, arthroscopic surgery has gradually been applied in clinical practice, especially knee arthroscopy. Due to its advantages of minimal trauma, precise localization, mild pain, and rapid postoperative recovery, it has become an ideal method for treating diseases such as knee cruciate ligament injury^[1], popliteal cyst^[2], and knee dislocation^[3]. Multiple studies have confirmed the effectiveness and feasibility of knee arthroscopy. It is worth noting that the incidence of postoperative complications and unexpected events after knee arthroscopy is 9.71%^[4], including joint effusion with abscess, joint hematoma, and venous thromboembolism (VTE). VTE is a common and serious life-threatening disease, including deep vein thrombosis (DVT) and pulmonary embolism (PE). Due to the lack of specificity in symptoms and signs, it is difficult to make a correct diagnosis in a timely manner. Therefore, it is recommended to pay attention to patients after knee arthroscopy and focus on the risk factors of VTE formation after surgery to guide the implementation of corresponding preventive measures. This study now reviews and analyzes the literature in recent years and provides the following review of the new progress in the risk factors of VTE after knee arthroscopy.

1 Overview of VTE

VTE refers to the formation of blood clots in the veins, characterized by hidden symptoms and high incidence. It includes DVT and PE. The former is manifested by symptoms such as pain, swelling, and redness in the lower limbs, while the latter is characterized by chest pain, rapid breathing, hypoxemia, and in some cases, hypotension, shock, and sudden death, which can endanger life. At present, VTE has become a common problem for patients undergoing orthopedic surgery. Surveys show that the incidence of DVT in the lower limbs of orthopedic patients is 10.5% to 61%, and the incidence of PE is 1.4% to 7.5%. There are also studies by scholars such as Guo Haoran^[5], who conducted research on patients with knee arthroscopy and found that the incidence of postoperative complications was 7.33%, which was closely related to the disease itself, surgical time, and surgical complexity.

2 New Progress in the Risk Factors of VTE after Knee Arthroscopy

2.1 Patient-Related Factors

In recent years, some scholars have reported on the risk factors for VTE after knee arthroscopy, suggesting that age, comorbidities, and obesity are related. For example, Xue Lei^[6] and others conducted research on patients with traumatic knee osteoarthritis (TKOA) and investigated the incidence and risk factors of lower limb DVT after arthroscopic microfracture surgery. The results showed that the incidence of lower limb DVT in patients after surgery was 24.0%, which

was related to factors such as age ≥ 60 years, hyperlipidemia, and Caprini score. Chen Jun^[7] and others also conducted a study on patients with knee arthroscopy and found that the incidence of postoperative venous thrombosis was closely related to age and Caprini score. The reasons are as follows:

As age increases, the elastic fibers and collagen fibers in the blood vessel walls will degenerate, reducing their elasticity. This weakens the blood vessels' ability to regulate blood flow pressure and impact, increases vascular levels, and affects blood flow velocity. It also accelerates platelet aggregation and the activation of coagulation factors, increasing the risk of thrombosis. Therefore, it is recommended to pay more attention to elderly patients undergoing knee arthroscopy, screen high-risk patients in time, and take corresponding preventive measures.

The Caprini risk assessment model, known for its simplicity and practicality, is widely used in clinical practice and has become one of the commonly used tools for evaluating VTE. The population applicable to this scale is hospitalized surgical patients. According to the total score of the scale, patients can be divided into four groups: low-risk (0 points), moderate-risk (1–2 points), high-risk (3–4 points), and very high-risk (≥ 5 points). In the study, the Caprini score of patients with thrombosis was (4.95 ± 0.48) , indicating that the risk of postoperative lower limb DVT formation increases with the increase of Caprini score.

Hyperlipidemia is a common chronic non-communicable disease, which is related to changes in people's lifestyles and excessive intake of high-fat, high-sugar, and high-salt foods. It increases the risk of other cardiovascular diseases in patients. Patients with hyperlipidemia have abnormal blood lipids, especially the abnormal increase in triglycerides and cholesterol levels, which deposit in the blood vessel walls, forming atherosclerotic plaques. This narrows the blood vessels and slows blood flow, promoting thrombus formation. Total cholesterol and triglycerides are the main components of blood lipids. The former can narrow the blood vessel lumen and damage the blood vessel endothelium, while the latter can increase the viscosity of red blood cell membranes, accelerate red blood cell sedimentation, and increase blood viscosity^[8]. Therefore, hyperlipidemia is considered a risk factor for lower limb DVT formation after knee arthroscopy. In addition, clinical practice has shown that obesity is also a risk factor for VTE after knee arthroscopy. BMI is one of the important indicators for evaluating the degree of obesity in patients, and a $\text{BMI} > 25 \text{ kg/m}^2$ is considered a risk factor for DVT formation. Obesity can increase the burden on the body, especially increasing the venous pressure in the lower limbs, causing poor blood return. After knee arthroscopy, patients are affected by anesthesia, surgical trauma, and restricted postoperative activity, leading to slowed blood flow in the lower limb veins, thereby increasing the risk of thrombus formation. Therefore, it is recommended to pay high attention to patients with knee arthroscopy who have the above factors, and to take measures such as preoperative education and preparation. For example, the advantages of knee arthroscopy, its current application status, the possible risk of VTE, and coping skills should be introduced in detail to emphasize the importance of preoperative examinations and encourage patients to cooperate with routine examinations. At the same time, the Caprini scale should be used to assess patients, screen high-risk patients who may develop VTE after surgery, pay close attention to them, and take corresponding intervention measures in time, such as preoperative lipid regulation and early postoperative activity.

2.2 Surgery-Related Factors

2.2.1 Type of Surgery

There are many types of knee arthroscopy, all of which can cause varying degrees of VTE in patients after surgery, especially those with more invasive operations during the surgery, who have a higher incidence of postoperative DVT. Clinical practice shows that knee arthroscopic anterior cruciate ligament reconstruction is more complex than meniscus surgery, simple arthroscopic examination, and cartilage formation surgery, and the risk of postoperative DVT formation is higher, with a risk increase of 17.2 times. Therefore, it is recommended to pay attention to the prevention of postoperative DVT in patients undergoing knee arthroscopic anterior cruciate ligament reconstruction. In practice, it is important to establish bone tunnels for ligament reconstruction and provide anticoagulant treatment within 3 weeks after surgery. Heparin (unfractionated heparin, low molecular weight heparin), vitamin K antagonists (warfarin) are commonly used drugs for patients undergoing knee arthroscopic anterior cruciate ligament reconstruction. Unfractionated heparin exerts its anticoagulant effect by inactivating thrombin and coagulation factors. However, during medication, it is necessary to closely monitor the patient's coagulation activity, and some patients may have drug-related adverse reactions that affect anticoagulation. Low molecular weight heparin has a better anticoagulant effect than unfractionated heparin, with higher bioavailability and longer half-life, and has become the preferred drug for preventing DVT^[9]. Warfarin is rapidly absorbed orally and has a significant anticoagulant effect. However, patients taking the drug need to regularly check their coagulation function to guide the adjustment of drug dosage and avoid serious adverse reactions. Rivaroxaban and apixaban, as new anticoagulant drugs, selectively inhibit factor Xa, reducing the activity of thrombin and exerting an ideal anticoagulant effect. These drugs can all be taken orally, are rapidly absorbed, and do not require monitoring and dose adjustment during use. Compared with low molecular weight heparin, rivaroxaban has a better preventive effect on DVT

after knee arthroscopy.

2.2.2 Use of Tourniquet Time

The use of tourniquets is a common method in orthopedic surgery, which can reduce intraoperative bleeding, improve the clarity of the surgical field, and shorten the surgical time. However, prolonged use of tourniquets during surgery can easily lead to postoperative thrombus formation. Li Hongli^[10] and colleagues conducted a study on elderly patients with knee meniscus injury undergoing arthroscopy and found that the incidence of postoperative lower limb DVT was 15.79%, which was related to the use of tourniquets during surgery. The reason is that the use of tourniquets during surgery can easily reduce the deformability of red blood cells and enhance platelet aggregation, thereby triggering thrombus formation. In addition, the continuous compression of tourniquets can easily stimulate the high expression of catecholamines in patients, leading to a hypercoagulable state of the blood. On this basis, some scholars have pointed out that the use of tourniquets for more than 90 minutes is an important factor in the formation of DVT after knee arthroscopic cruciate ligament reconstruction, and it is also related to postoperative bed rest for ≥ 3 days and surgical duration of ≥ 1 hour. Therefore, it is recommended to use antithrombotic drugs prophylactically for 5-7 days, optimize the surgical operation process to ensure more professional and standardized surgical steps, and use tourniquets reasonably during surgery. In addition, according to the postoperative condition and rehabilitation needs of patients, guide them to perform ankle joint exercises, and if necessary, assist with graduated compression stockings, intermittent pneumatic compression pumps, thromboelastography, and other measures to prevent lower limb DVT formation. Yang Yang^[11] and colleagues took patients undergoing knee arthroscopy as an example and divided them into tourniquet group and leg elevation group. No lower limb DVT occurred in either group, but there were more cases of lower limb muscular vein thrombosis. The incidence of muscular vein thrombosis in the tourniquet group was 28%, higher than that in the leg elevation group (16%), indicating that the combined use of tourniquets and blood expulsion bands can increase the risk of postoperative lower limb muscular vein thrombosis in patients, but it does not increase the incidence of postoperative DVT. Zhang Zhongqing^[12] and colleagues took patients undergoing knee arthroscopy as an example to explore the predictive value of thromboelastography for postoperative thrombus formation and its impact. The results showed that personalized anticoagulation under thromboelastography monitoring was more significant in preventing thrombus formation.

2.3 Factors Related to Coagulation Function

D-dimer, as a specific marker of the fibrinolytic process, is highly sensitive to thrombus formation and has become an important indicator for evaluating coagulation status in clinical practice. It has important guiding significance for thrombus formation after knee surgery in patients. When detecting D-dimer, patients should be advised to abstain from alcohol, avoid high-fat diets, strenuous exercise, and oral anticoagulant drugs to prevent the results from being affected by drugs and diet. Wu Wenguang^[13] and colleagues conducted a study on patients undergoing knee replacement surgery and found that the occurrence of postoperative thrombus was related to the levels of plasma LPA, TGF- $\beta 1$, and D-D. The reason is that surgical trauma and postoperative immobilization can both affect the blood viscosity of patients, leading to a hypercoagulable state of the blood and thereby triggering thrombus formation. Therefore, it is recommended to improve preoperative biochemical tests for patients to clarify the coagulation function status, and to inquire about the basic situation of patients to determine whether there is a history of drug overdose and past medication use, in order to reasonably formulate the surgical plan.

3 Conclusion

Knee arthroscopy, in line with the concept of minimally invasive surgery, has been widely used in clinical practice and is highly praised and favored by patients. In recent years, knee arthroscopy has become an ideal method for treating diseases such as knee dislocation and cruciate ligament rupture. At the same time, postoperative VTE has attracted attention. Through the review and analysis of relevant literature, this study analyzes the overview of VTE and focuses on exploring the risk factors for VTE after knee arthroscopy. It has been found that the incidence of VTE after knee arthroscopy in China remains high, which is the result of the combined action of patient-related factors, surgery-related factors, and coagulation function-related factors. Therefore, it is recommended to pay attention to patients with the above factors, actively take measures such as preoperative preparation, prophylactic use of anticoagulant drugs, and early activity. At present, how to quantify the risk factors for VTE after knee arthroscopy has become an important issue that medical staff need to solve. The construction of a risk assessment scale for VTE formation after knee arthroscopy is a priority to guide the formulation of targeted preventive intervention strategies and to maximize the clinical efficacy and

treatment safety of patients undergoing knee arthroscopy.

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