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Surgical Prevention of Thrombosis in Modern Conditions

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ABSTRACT

The article discusses the features of surgical prevention of thrombosis in modern conditions. The author notes that due to the high risk of death, thrombosis that occurs during surgical interventions of various types have a significant impact on the quality of medical care in the surgical environment. Accordingly, it is very important to determine the risk of postoperative venous thromboembolism and evaluate the features of its prevention. A particular risk is the development of venous thromboembolism (VTE), which combines deep vein thrombosis (DVT) and pulmonary embolism (PE). Experts call it a multifactorial and serious disease. Accordingly, it is very important to study theoretical and practical approaches to the organization of prevention of thrombosis in particular and VTE in general in surgical practice, since even a competently and effectively performed operation can cause the death of a patient.

Accordingly, the purpose of this work is to identify the features of surgical prevention of thrombosis and VTE in modern conditions.

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INTRODUCTION

The overall risk of thromboembolism is associated with various causes, one of which is surgery. The prevalence of VTE risk in surgery is more than 50% in developed countries and exceeds that by almost one and a half times in developing countries.[1] A patient who has undergone serious surgery has a 20-fold risk of VTE, and this risk increases by 30% in the absence of optimal prevention. Due to its role in increasing morbidity and mortality, as well as increasing the cost of medical care, venous thromboembolism (VTE) has a significant impact on the quality of medical care in the surgical environment. For this reason, the assessment of the risk of VTE in patients who have undergone various surgical interventions and thromboprophylaxis is important.[2]

Despite the high prevalence of VTE risk factors, only 58.5% of surgical patients in the world received thromboprophylaxis. The need to prevent venous thromboembolism in surgical patients is due to the high incidence of these pathologies in the postoperative period and their negative impact on morbidity and mortality.[3]

The risk of VTE after surgery is a result of the risk associated with the patient (location, disease) and the risk specific to the procedure.

A comparative study aimed at identifying the main causes of thromboembolism determined that among these, extensive surgical intervention (87.5%), age > 40 years (72.5%), bed rest (68.8%), malignant neoplasms (33.8%) and obesity (27.5%) can be designated.[4] Thus, in most surgical patients, the level of thromboembolic risk requires perioperative prevention of VTE.

Postoperative thromboprophylaxis is usually based on early mobilization of patients (92.5%).[5] This can be explained by the fact that it is preventive measures that are the simplest and least costly to implement. Current studies confirm that early postoperative rehabilitation and outpatient surgery have a positive effect on reducing the frequency of postoperative thromboembolic complications.[6]

KEYWORDS:
Deep vein thrombosis, Pulmonary embolism, Venous thromboembolism, Surgical interventions, Thromboprophylaxis.

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The appointment of pharmacological prophylaxis depends very much on the financial capabilities of patients, respectively, the percentage of patients who can receive it is not high enough.

The duration of drug prophylaxis is quite clearly defined in international recommendations and usually ranges from 10 to 15 days after surgery, except in cases of extensive surgery for malignant neoplasms, in which it is recommended to continue thromboprophylaxis for 4-5 weeks. In the absence of effective postoperative thromboprophylaxis, the frequency of VTE increases dramatically.

The aim of the study is to identify the features of surgical prevention of thrombosis and VTE in modern conditions.

MATERIALS AND METHODS

In the process of writing the study, the theoretical and practical experience of medical specialists in the organization of thrombosis of various nature arising after surgical interventions was studied. The data obtained were systematized and described through the use of comparative and analytical research methods.

RESULTS

Deep vein thrombosis (DVT) is caused by a blood clot that interferes with blood flow in the deep vein system, most often in the lower extremities. It can be triggered by factors such as a recent operation or injury, hospitalization with prolonged bed rest or taking oral contraceptives. Unprovoked DVT can be an idiopathic, hereditary, or acquired hypercoagulation condition, such as cancer and pregnancy. It is estimated that the annual incidence of venous thromboembolism (VTE) worldwide is 10 million. DVT is observed in approximately 0.51% of hospitalized patients, 0.8–8% of cancer patients, 0.8–9.6% of patients after surgery and 5-31% of patients in intensive care units (ICU), and the incidence increases with age.[7]

A study based on a large database of healthcare in China showed that the annual incidence of DVT is 30.0 per 100,000 population. Possible complications of DVT are pulmonary embolism, postthrombotic syndrome, bluish phlegmasia, white phlegmasia and paradoxical embolism leading to cryptogenic embolic stroke. In addition, DVT is associated with an increased risk of mortality.

Risk factors for DVT include transient or permanent factors that can additively or synergistically increase the risk of thrombosis, causing damage or dysfunction of the vascular wall, stasis or hypercoagulation of blood. Patients in the intensive care unit have many risk factors for DVT, including prolonged immobilization, use of sedatives and analgesics, deep vein catheterization, tracheotomy, surgical or invasive procedures, and possibly cancer, among others. All these factors will increase the risk of DVT in a population of patients at high risk of morbidity and mortality. Therefore, prevention of DVT is crucial for ICU patients. However, most studies on the epidemiology, prevention and treatment of DVT in intensive care units are conducted in Western countries, and data on developing countries such as China are not available. Among 80 patients in the intensive care unit for 9 months in a Hong Kong hospital, the incidence of DVT in the intensive care unit was 15 patients with an incidence rate of 18.8%.[8]

Prevention of VTE in hospitalized patients is a complex clinical task, since it requires balancing the risk of developing DVT and complications associated with DVT, and the risk of complications associated with prevention, mainly bleeding. Currently, recommendations for patients in critical condition indicate that pharmacological prophylaxis (using unfractionated heparin [UFH] or low molecular weight heparin [NMH]) should be preferable to mechanical prophylaxis. However, if the patient has bleeding or a high risk of bleeding, mechanical prophylaxis should be considered until the bleeding stops or the risk of bleeding decreases, and then the possibility of switching to pharmacological prophylaxis should be considered.[9]

Venous thromboembolism (VTE), a blockage of a vein by a thrombus, is a generic term for two related diseases: deep vein thrombosis (DVT) and pulmonary embolism (PE). The most likely site of DVT is the deep veins of the lower leg (60%), called distal DVT. Less likely locations include femoral veins (22%) and popliteal veins (7.8%), collectively referred to as proximal DVT.

DVT often occurs at the sites of vascular injuries or in areas with slow-moving or static blood (for example, around the valve flaps), which causes local blood clotting and the formation of blood clots. Thrombosis usually begins in the veins of the lower leg and can spread to the proximal veins. Distal DVT may not be associated with serious complications, since they can spontaneously lyse. However, they become clinically important if they spread proximally. If then a venous thrombus breaks off and moves to the arteries in the lungs and clogs them, this is called a PE.[10]

Symptoms of DVT may include pain, erythema, fever, soreness and pathological swelling of the lower leg or thigh of the affected limb. First-time atrial fibrillation, unexplained shortness of breath or cough may indicate a PE. However, 90% of patients diagnosed with PE may lack signs of previous DVT.

DVT can be diagnosed in several ways, including d-dimer tests, plethysmography (assessment of changes in the volume of blood flowing through the limb) and studies that visualize a blood clot (for example, venography, ultrasound, spiral computed tomography and magnetic resonance imaging). PE can be examined using radionuclide ventilation-perfusion scanning or CT angiography of the lungs. The search for DVT or PE in asymptomatic surgical patients is not a routine practice.

In 1846, the German pathologist Rudolf Virchow described a triad of risk factors for VTE: stagnation of venous circulation, hypercoagulation and injury to the walls of blood vessels. Only one of these factors is necessary for the formation of blood clots.[11]

1. Stagnation of venous circulation. Normally, when a person walks, the plantar venous plexus of the foot is compressed. This, together with the contraction of the calf muscles, promotes blood from the lower extremities back to the heart. Perioperative immobility deprives the deep veins of the legs of the pumping action of the calf muscles. Venous blood stagnation (decreased blood flow rate due to venous dilation and stagnation or venous obstruction), especially behind the valves of deep veins, predisposes to thrombosis. It is also assumed that venous stagnation inhibits the ability of blood to carry away locally activated blood clotting factors — their concentration increases and potentiates further clot formation.

2. Conditions of hypercoagulation. Hypercoagulation states alter the normal mechanisms of blood hemostasis. They can occur due to a number of inherited or acquired conditions. Acquired conditions include antiphospholipid syndrome, systemic lupus erythematosus and true red polycythemia. Hereditary conditions include Leiden factor V mutation, protein C or S deficiency, and antithrombin III deficiency.
   Hypercoagulation can also occur as a result of dehydration (hemoconcentration is associated with an increase in blood viscosity and a decrease in blood flow). It was suggested that patients with idiopathic VTE may have a genetic predisposition to hypercoagulation, which remained subclinical until an additional risk factor arose (for example, immobilization in the perioperative period).
3. Injury. Damage to the endothelium caused by the initial injury (for example, bone fractures or soft tissue bruises) or direct vascular damage (for example, damage to the endothelium during subsequent surgery) may predispose to the occurrence of thrombosis. Normally, the endothelial lining of blood vessels is smooth with a negatively charged layer of surface proteins. If the vessel wall is damaged, its lining loses its negative charge and becomes uneven, causing adhesion and platelet aggregation and triggering a coagulation cascade.

Micro-fractures of the walls of blood vessels can also occur as a result of stretching and venous stagnation. General anesthesia reduces vascular tone and dilates veins. The state of hydration and the patient's position during surgery affect the degree of venous dilation.

Other factors predisposing to VTE include old age, obesity, taking medications (for example, hormone replacement therapy, combined oral contraceptives or tamoxifen), a history of VTE (personal and family) and venous obstruction due to external compression (for example, a tumor). Malignant neoplasm is usually associated with an increased risk of VTE. In most cases, VTE occurs due to a combination of hereditary or acquired predisposition and external circumstances. However, 30 to 40 percent of cases are idiopathic.

Risk factors in the immediate postoperative period include:

1. The nature and duration of the operation
2. The anesthesia method used
3. The degree and duration of immobility (including after discharge from the hospital)
4. The presence of dehydration or sepsis

Despite the well-documented morbidity and mortality associated with VTE, patients often receive inadequate prevention. This is due either to an unintentional omission, or to the use of a lower level of prevention than corresponds to the level of risk. The Consensus Group on Thromboembolic Risk Factors (THRIFT) recommends evaluating all inpatient patients for VTE risk and conducting appropriate antithrombotic prophylaxis. He suggests that hospitals develop their own recommendations for the prevention of VTE, using his recommendations as a guide. You can also contact other recognized national and international organizations for recommendations. Many hospitals base their recommendations on thromboprophylaxis on the categories of thromboembolic risk "low", "moderate" and "high".[12]

In practice, protocols differ in the details of risk stratification and proposals. Good practice should include the use of a validated risk assessment tool (for example, the Autar of the DVT risk assessment). The risk of DVT should be assessed taking into account the patient's medical history, clinical signs, existing conditions (for example, varicose veins, obesity, heart failure, paralysis) and the type of surgical intervention (nature and duration), as well as the results of any general blood tests (for example, the number of platelets to exclude thrombocytopenia) or specialized blood tests (for example, Leiden mutation of factor V and the status of proteins C and S) for the detection of blood clotting disorders. The Scottish Inter-University Network of Recommendations provides an idea of the percentage increase in the risk of developing VTE for a number of risk factors. After risk assessment, the most appropriate form of prevention can be selected in accordance with local recommendations. Extended prevention of DVT can be continued after discharge if the patient is not fully mobile or is still at risk for other reasons.

The frequency of deep vein thrombosis is one to two people per 1000 population per year. Postoperative VTE is a serious danger for patients who have undergone surgery. Without prevention, the average frequency of all DVT ranges from 9% after transurethral prostatectomy to more than 50% with major orthopedic interventions, and the frequency of PE ranges from 1.6% in general surgery to 6.9% after traumatic orthopedic surgery. The frequency of fatal PE ranges from 0.87% in general surgery to 4% in inpatient patients with femoral neck fracture.[13]

The recurrence rate of VTE is approximately 7% after six months, and death occurs in approximately 6% of patients with DVT and in 12% of patients with PE within one month after diagnosis. There is also a significant incidence due to post-thrombotic syndrome (i.e. leg pain, venous ulceration or eczema) affecting about 10% of patients with symptomatic DVT within five years.and from 20 to 30 percent of patients within 13 years after acute DVT.[14]

DISCUSSION

Although the risk of developing VTE after surgery has decreased in recent decades, the cost of treating VTE-related events remains high. For example, a quarter of cases of venous ulcers are associated with previous DVT and cost the NHS about 400 million pounds a year.

In the absence of prevention, DVT or PE often develops. The development of VTE complications is most likely in the first days after surgery. The most effective way to prevent VTE is routine prophylaxis for all patients with moderate and high risk.

For patients who have undergone surgery, a triple regimen should be used (if there are no contraindications). This may include mechanical methods to improve blood flow, pharmacological therapy, and other general measures such as hydration and pre- and postoperative physiotherapy to reduce blood clotting. Immobility increases the risk of DVT by 10 times, so early mobilization and leg exercises should be encouraged.

Mechanical methods prevent VTE by increasing the average blood flow in the veins of the lower extremities, which reduces venous congestion. Their advantage is that they do not increase the risk of bleeding, so they are effective in patients who should avoid the use of antithrombotic drugs. Mechanical "devices" include:

- graduated elastic compression stockings (GECS);
- intermittent pneumatic compression (IPC) devices, such as uniform or sequential compression devices;
- mechanical foot pumps;
- filters of the inferior vena cava

1. Elastic compression stockings with graduated compression. Step compression involves the application of constant efforts to the limb, with a high level of compression in some places and less in others. GECS (e.g. stockings to prevent thromboembolism [TED]) are widely used in the UK. With the right selection, they contribute to the effective emptying of leg veins, thereby reducing stagnation. It is believed that the application of graduated circumferential pressure from distal to proximal regions in combination with normal muscle activity in the limb displaces blood from the superficial to the deep venous system through the perforant veins and proximally from the limb. Increased venous pressure in the legs increases the speed of blood flow in the deep system. However, with the wrong size, GECS can also squeeze the arteries, which leads to circulatory disorders.

GECS also reduce the diameter of the veins and bring the valve flaps into opposition, restoring patency and preventing venous reflux. Reducing venous bloating reduces the occurrence of micro-fractures in the endothelium. Clinical data presented by MycoHealthcare indicate that TED stockings reduce the occurrence of DVT by 68%.[15]

Stockings below the knees may be more comfortable for patients with swollen or arthritic knees, and it is easier for patients to put them on without assistance. They can also be useful for patients who are too large or small for an optimal fit of stockings on the entire leg, as well as for patients who have undergone surgery on the upper part of the leg. However, SIGN recommends, where possible, using thigh-high stockings rather than knee-high stockings (even though patients find knee-high stockings more acceptable), since a significant amount of DVT develops above the knee.

In order to avoid injury and discomfort, as well as to achieve optimal prevention, attention should be paid to:

- correct size and installation according to the manufacturer's instructions;
- daily check of the fit (since the circumference of the leg may vary);
- lack of rolling of the stocking (to avoid the effect of a tourniquet — this can interfere with venous outflow and increase venous accumulation and formation of blood clots);
- absence of stockings on the body for more than 30 minutes a day;

The data also indicate that the combination of TED stockings with heparin leads to a greater reduction in the frequency of DVT compared with the use of heparin alone. The use of Compression Stockings (GECS) with pharmacological prophylaxis or Intermittent pneumatic compression (IPC) in surgical patients is aimed at solving all three aspects of the Virchow triad. That is, an increase in the rate of venous return (thereby reducing stagnation), stimulation of regional fibrinolytic activity (thereby reducing hypercoagulation) and a decrease in venodilation (thereby reducing endothelial damage).

Contraindications to the use of stockings are:

- local skin diseases (e.g. dermatitis, recent skin grafting);
- severe ischemia or peripheral vascular disease (to prevent further decrease in arterial circulation);

peripheral neuropathy;

- pronounced swelling of the leg or lungs;
- extreme deformity of the leg;
- known sensitivity to the material of the stocking.

2. Intermittent Pneumatic compression (IPC) devices. IPC devices consist of inflatable clothing for the limb and an electric air pump that fills the clothes with compressed air. The clothes inflate and deflate, periodically squeezing the calf muscles or thigh muscles (or both) around the circumference (the pressure chamber wraps around the leg) and stimulating fibrinolysis. Cycle time and pressure vary.

First, compression pushes blood from the superficial veins into the deep ones and increases the speed of blood flow into the femoral veins. This reduces venous congestion, blood accumulation and venous congestion. It also enhances endogenous fibrinolytic activity.

IPC devices are especially useful in the immediate perioperative period, but some patients do not tolerate them because they are somewhat cumbersome. The use of IPC in patients with fractures, plaster dressings or external fixation devices may not be appropriate. Teaching patients the functions of the device and additional functions (for example, cooling systems) can improve compliance with the regime.

IPC devices provide uniform or consistent compression. Sequential compression devices send compression waves up the leg and seem to be more effective than uniform compression to prevent DVT. The Flowtron Excel system is an example of a universal compression device.[16]

It has been reported that sequential graduated compression provides a greater and more stable rate of venous blood flow than uniform compression. A sequential device provides better emptying of the vascular network than a uniform device and maximizes the gap between the valves of the venous valve.

The device has annular, sequential, graduated compression (the highest pressure on the ankle, the average pressure on the calf and the lowest pressure on the hip), as well as automated and personalized settings.

3. Mechanical foot pumps. Mechanical foot pumps are designed to eliminate venous blood stagnation. When worn, it flattens the metatarsal arch and empties the plantar venous plexus, reproducing the effect of a normal

weight load. Mechanical foot pumps are effective for the prevention of DVT and are often used for orthopedic patients, especially in cases where IPC devices or stockings cannot be used.

Compression devices for the foot cannot restrict blood flow in the upper part of the lower leg, which potentially contributes to better emptying of blood vessels. Compliance with the patient's regime is improved due to comfort and ease of use. Foot pumps also reduce vasodilation, reducing the risk of damage to the endothelial lining. By increasing the speed of blood flow, they promote the movement of locally activated blood clotting factors, and also enhance fibrinolysis. They are especially useful for injuries and in patients with severe obesity.[17]

Different foot pumps use different speeds and pressures. The pulse technology of the foot (for example, used by the AV Impulse System) has been recommended for prevention during planned hip replacement in accordance with an international consensus statement.

4. Filters of the inferior vena cava. Inferior vena cava filters are injected percutaneously under X-ray control, usually through the femoral vein, and represent a physical barrier to emboli. They are useful when anticoagulant therapy is contraindicated or in patients who develop a relapse of PE despite adequate anticoagulant therapy. Filters are also used in patients with a high risk of proximal DVT expansion or pulmonary embolism. Filters of the inferior vena cava prevent PE, but do not stop the thrombotic process and do not prevent venous thrombosis.[18]

Also, if necessary, anticoagulant therapy and surgical treatment of DVT should be carried out. Although systemic anticoagulant therapy does not solve current thrombosis, it has been shown to eliminate the symptoms of DVT and reduce the risk or prevent PE, recurrent DVT and CVI. Anticoagulant therapy should be started immediately after the suspicion of DVT, before the return of diagnostic tests, if the suspicion is strong or the results of diagnostic tests will be delayed

Systemic administration of thrombolytics for active thrombus lysis is not recommended, as it does not lead to a significantly lower risk of cardiovascular diseases, but is associated with a higher risk of bleeding and death.[19]

The first-line therapy is intravenous administration of unfractionated heparin (UFH) using an electronic infusion device to prevent an administration error. Patients should be monitored for bleeding and heparin-induced thrombocytopenia (GIT), a rare but serious disease.

Oral anticoagulants (e.g., warfarin, dabigatran, rivaroxaban, apixaban, edoxaban) are suitable for use as long-term anticoagulant therapy. Warfarin is the only oral anticoagulant that requires laboratory control.

However, ASC cannot be the only therapy for the prevention of DVT, but should be prescribed in combination with the use of a compression device. ASA therapy does not reduce the risk of bleeding. Patients on ASC are at a higher risk of gastrointestinal bleeding.

Surgical or endoscopic treatment, including thrombectomy, can be used to treat DVT, especially when the thrombus is large and in the proximal (iliac or common femoral) vein. Installing a filter in the inferior vena cava (NIP) may be prescribed to prevent PE in those who cannot take anticoagulants, but this is considered a last resort due to the risk of infection and chronic thrombosis associated with the device.

CONCLUSION

Venous thromboembolism is a serious, fatal and frequent disease in surgical conditions. The recommended preventive measures are not sufficiently applied in our conditions. Mastering the assessment of perioperative thromboembolic risk and careful application of preventive measures will improve the quality of medical care.

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