

# Development of prophylactic measures for lower extremity deep vein thrombosis after spinal surgery

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**【Abstract】** Since spinal surgery is prone to lower extremity deep vein thrombosis for many reasons, once the lower extremity deep vein thrombosis occurs, it will affect the recovery of the disease, cause physical and psychological distress to the patient, increase the financial burden of the patient, and even cause embolism of the pulmonary artery because of the detachment of the thromboembolus, resulting in a serious outcome for the patient's death. In recent years, many scholars have done a lot of theoretical and clinical research efforts on DVT prevention after spine surgery, and the same nurse plays a vital role in the prevention and treatment of lower extremity deep vein thrombosis. In this review, we summarize the recent progress in the knowledge of the related factors, risk assessment, and preventive measures for DVT after spinal surgery, with a view to better developing effective preventive measures in clinical work and reducing the incidence of DVT after spinal surgery.

**【Key words】** Spine surgery; Lower extremity deep vein thrombosis; Preventive measures; Research advances

Deep vein thrombosis (DVT) mainly refers to the abnormal coagulation of blood in deep vein, which leads to venous reflux disorder caused by vascular cavity obstruction[1]. The fall off of thromboembolus is easy to cause pulmonary embolism, which seriously threatens the life of patients. It is reported in relevant literature that its mortality rate is only second to that of tumor and myocardial infarction[2]. Generally speaking, the incidence of DVT after spinal surgery is high, mainly due to the large surgical trauma and long postoperative bedtime. Relevant reports show that the incidence of DVT after spinal surgery is between 0.9% and 15.5%[3], about 1/2 of which occurs on the first day after surgery and about 1/3 on the second day after surgery[4]. However, the clinical manifestations of DVT are relatively hidden and difficult to detect in time, which brings great difficulties to the treatment and nursing of patients. This article reviews the factors and preventive measures of DVT after spinal surgery.

## 1 Risk factors of DVT formation after spinal surgery

The risk factors of DVT formation after spinal surgery include venous wall injury, slow venous blood flow and hypercoagulable state. The etiology of patients after spinal surgery includes the following aspects. 1. Due to the long time of spine surgery, the patient's lying position is easy to cause the femoral vein or iliac vein to be compressed for a long time[5]; 2. General anesthesia can reduce blood flow of lower limbs; 3. Stimulation of some implants used in surgery; 4. Long-term bed rest after operation will cause blood flow to slow down; 5. The stimulation of surgical stress factors will lead to the increase of platelet value and blood adhesion. A large

amount of blood loss during the operation will lead to blood concentration[6], making the blood in hypercoagulable state;6. In terms of medication, mannitol is a hypertonic dehydration drug, which can improve the edema of nerve root after spinal surgery. It is the most commonly used drug in spinal surgery. After medication, it will cause blood concentration and hypercoagulability. In addition to being irritating to blood vessels, it is easy to cause phlebitis and increase the incidence rate of DVT;7. Patients with cardiovascular and cerebrovascular diseases, long-term smoking history and obesity may increase the incidence rate of DVT.

## **2 Risk assessment of DVT**

Applying scientific and effective thrombus risk assessment tools to accurately assess the risk of lower limb DVT in fracture patients is the premise for nurses to screen high-risk groups and implement prevention. At present, the commonly used international scales to predict the risk of deep venous thrombosis include the Caprini scale, the Autar scale, the Wells scale, and the Geneva scale.

The Caprini risk assessment model, with 38 risk factors in the assessment scale, is divided into four groups according to the total score: low risk 0-1, medium risk 2, high risk 3-4, extremely high risk  $\geq 5$ , and different preventive measures are recommended according to the risk stratification. The Caprini risk assessment model is effectively based on individual risk factors and quantifying DVT risk. The scale has strong applicability and is widely used at home and abroad[7].

The Autar thrombus risk assessment scale was designed by Autar in 1996[8]. The scale covers seven risk factors, including age, BMI, activity, special risk category, trauma, surgery and high-risk disease, with scores of 1-7. No risk  $< 7$  points, low risk 7-10 points, medium risk 11-14 points, high risk  $\geq 15$  points. The items such as bed rest and specific activity ability in the Autar scale reflect the characteristics of patients after orthopedic surgery, and the Autar scale originated from orthopedics, which is more targeted in terms of disease type and population.

Wells Assessment Risk Scale is the most widely used scale in the world. Seven risk factors were included: previous thrombotic history, heart rate, hemoptysis, active tumor, surgery or immobilization history within 4 weeks, DVT symptoms and signs, and other diagnoses except PE. The uncertainty and subjectivity of clinical diagnosis will misestimate the risk of DVT, resulting in its infrequent use in China[9].

## **3 DVT prevention measures**

At present, there is no unified standard for the prevention of DVT after spinal surgery, and each medical unit also has its own prevention strategy. The North American Spinal Surgery Association recommends that all patients after spinal surgery should take certain preventive measures to reduce the incidence of thrombosis. The prevention of thrombosis after spinal surgery mainly includes basic prevention, mechanical prevention and drug prevention. Basic prevention and mechanical prevention can be carried out before operation until the patient is completely out of bed.

## **4 Basic preventive measures**

1. Carry out health education for patients undergoing spine surgery to make them understand the relevant factors of DVT, so as to improve their compliance and self-care ability;
2. After the operation, patients need to

perform axial rotation at a fixed time  $\leq 2$  hours/time, raise both lower limbs by 20-30 degrees, and promote venous reflux;3. Patients who can take the initiative to perform early functional exercise of both lower limbs can be instructed to perform ankle pump exercise of both lower limbs after the anesthesia is awake after the operation, with 30°back extension for 3-5 seconds, and then 45°plantar flexion for 3-5 seconds, one time for 3-5 minutes, 8-10 times a day, 300 times a day. Patients who are unable to actively move can passively massage soleus and gastrocnemius muscles of both lower limbs on the day after operation, and can also passively move ankle joints. On the first day after operation, straight leg lifting training and knee bending exercise can be performed in bed. The amount of exercise should not be too large, and the patient should not feel tired;4. Get out of bed at an early stage. Some literature studies have pointed out that assisting patients to get out of bed at an early stage can significantly reduce the incidence of DVT[10]if the patient's condition allows;4. Protection of blood vessels: try to avoid blood transfusion of lower limbs, avoid too long binding time of tourniquet if necessary, avoid multiple punctures at the same site, and prevent drug extravasation;5. It is recommended that patients change their lifestyle, such as drinking more water, drinking about 2000 ml per day, and quitting smoking and drinking;6. Control blood sugar and lipids. There are literature reports that the blood of patients with diabetes and hyperlipidemia is in a hypercoagulable state, the blood lipid index is poor, and the incidence of lower limb deep vein thrombosis is high[11].

## 5 Mechanical precautions

At present, the mechanical preventive measures for clinical use mainly include intermittent inflation pressure pump, gradient pressure hose and plantar vein pump. These preventive measures can make patients'lower limb muscles contract, promote blood circulation, slow and prevent blood stasis in lower limb veins, so as to achieve the purpose of preventing and reducing the occurrence of DVT. For patients with few high-risk factors and high bleeding risk after spinal surgery, mechanical preventive measures should be taken to prevent DVT rather than anticoagulant drugs, which can reduce the potential bleeding risk caused by the use of anticoagulant drugs. The study points out that the risk of DVT formation can be reduced by 2/3[12]when using mechanical measures to prevent DVT. The guidelines for the diagnosis and treatment of DVT in China point out that gradient pressure socks and intermittent inflation pressure pumps are important measures to prevent the occurrence and recurrence of DVT. Before using the intermittent inflation pressure pump, select a leg sleeve of appropriate size, evaluate whether there are wounds, skin damage and blood circulation in both lower limbs, to avoid the effect of tourniquet. At present, there is no specific conclusion on the use time and frequency of the intermittent inflation pressure pump. It is recommended to use it for 18 hours every day. For patients who are completely unable to move, the time should be extended as much as possible[13], and the specific tolerance of patients should be considered. Gradient pressure socks should be of appropriate size. When wearing them, the toes should be straightened so that the ankle and back of the foot are flat and free of wrinkles. In any case, it is forbidden to turn over the socks and fold the pressure band. The triangular buffer bandage should be located on the inner side of the thigh. During use, it is recommended to wear it in the daytime and at night, and pay attention to observe the blood circulation of the limbs, such as skin temperature, color and the pulse of the

dorsal artery of the foot. The plantar vein pump needs to pay attention to the pressure adjustment. If the pressure is too high, it is easy to cause skin crush injury. If the pressure is too low, it can not play an effective role in some people with strong muscle function, but it can not reach the ideal state under experimental conditions in clinical practice.

## 6 Drug precautions

According to the guidelines for diagnosis and treatment of DVT, drug treatment is an effective way to prevent DVT. The use of anticoagulants in patients after spinal surgery is controversial in the medical field. Some experts and scholars believe that extensive use of anticoagulants after spinal surgery can lead to increased incision bleeding, wound hematoma, etc. It is not recommended to use anticoagulants, but some scholars believe that appropriate use of anticoagulants will not cause the above problems. At present, common drugs are divided into the following categories:

1. Heparin mainly includes ordinary heparin and low molecular weight heparin. (1) Ordinary heparin may have individual differences, and it is easy to cause thrombocytopenia, so it is rarely used in clinic at present. (2) Low-molecular-weight heparin can be adjusted appropriately according to the patient's own conditions, with higher safety. Tang Liang[14] and other scholars pointed out that on the basis of full and complete hemostasis in spinal surgery, low molecular weight heparin can be used without causing the risk of massive hemorrhage and hematoma in the spinal canal.
2. Aspirin is an anti-platelet aggregation drug, which can be used in small doses for a long time.
3. The common drug of factor Xa inhibitor is Avaxaban, the individual difference of drug use is relatively low, the dosage is fixed, there is no significant antiplatelet function, and the treatment safety is high.
4. Vitamin K antagonist The dose of this drug needs to be adjusted frequently, and the patient's compliance is poor.

During the use of anticoagulant drugs, the vital signs of the patients should be closely monitored, the venous blood collection should be carried out according to the doctor's instructions to check whether there is any abnormality of coagulation function, the bleeding of the wound dressing, the color, nature and quantity of the wound drainage fluid should be observed, the gingival and subcutaneous bleeding should be observed, and the doctor should be notified in time to deal with the abnormality.

## 7 Discharge guidance

When the patient is discharged from the hospital, he/she should be informed to continue moderate functional exercise activities, try to avoid sitting, squatting and standing for a long time, and go to the hospital clinic regularly to check whether the preventive measures are effective, so as to change the plan and measures in time. Finally, the patient should also be informed of the early clinical symptoms of lower limb DVT. If there is any abnormality, timely seek medical advice.

## 8 Summary

The formation of DVT after spinal surgery is a common complication, which will pose a major threat to the life and health of patients. However, the early clinical symptoms of DVT are not obvious, and there are many

factors affecting DVT. However, some studies have shown that in clinical work, there are still some problems such as non-uniform prevention and treatment standards for lower limb DVT, incomplete training of relevant knowledge, and untimely updating of knowledge. Therefore, in clinical practice, we should pay full attention to prevention rather than treatment, strengthen nurses' understanding of deep venous thrombosis of lower extremities, improve risk assessment ability, and implement predictive and targeted preventive measures for patients, so as to reduce the incidence of deep venous thrombosis of lower extremities. At present, the main preventive measures include basic prevention, mechanical prevention and drug prevention. These measures have achieved significant results in clinical application.

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## 脊柱手术后下肢深静脉血栓预防措施的研究进展

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**【摘要】**脊柱手术后由于多种原因易发生下肢深静脉血栓,一旦发生下肢深静脉血栓,会影响了疾病的恢复,给患者带来身心痛苦,增加了患者的经济负担,甚至会因为血栓栓子脱落而引起肺动脉的栓塞,造成患者死亡的严重后果。近年来,许多学者对脊柱手术后 DVT 的预防进行了大量的理论和临床研究工作,同样护士在下肢深静脉血栓的预防和治疗中起着至关重要的作用。本文综述了近年来脊柱手术后 DVT 的相关因素、危险性评估及预防措施的研究进展,以期在临床工作中更好地开展有效的预防措施,降低脊柱手术后 DVT 的发生率。

**【关键词】**脊柱手术; 下肢深静脉血栓; 预防措施; 研究进展

深静脉血栓 (DVT)主要是指深静脉内的血液发生不正常凝结,从而导致血管腔阻塞形成的静脉回流障碍疾病<sup>[1]</sup>。血栓栓子脱落易引起肺栓塞,严重威胁患者的生命,有相关文献报道其导致病死率仅次于肿瘤和心肌梗塞<sup>[2]</sup>。一般来说,脊柱手术后 DVT 的发生率较高,主要原因是手术创伤大,术后卧床时间长。相关报道显示,脊柱手术后 DVT 的发生率在 0.9%-15.5%之间<sup>[3]</sup>,约 1/2 发生在术后第 1 天,约 1/3 发生在术后第 2 天<sup>[4]</sup>。但 DVT 的临床表现相对隐匿,难以及时发现,给患者的治疗和护理带来很大困难。本文就脊柱手术后并发 DVT 的因素及预防措施作一综述。

### 1 脊柱手术后 DVT 形成的风险因素

脊柱手术后 DVT 形成的危险因素包括静脉壁损伤、静脉血流缓慢和高凝状态。脊柱手术后患者的病因包括以下几个方面。1. 由于脊柱手术时间过长,患者卧位容易导致股静脉或者髂静脉长时间受压迫<sup>[5]</sup>; 2. 全身麻醉可降低下肢血流量; 3. 手术中使用的一些植入物的刺激; 4. 术后长时间卧床会导致血流减慢; 5. 手术应激因素的刺激会导致血小板值升高,血液粘附力增强,术中大量失血会导致血液浓缩<sup>[6]</sup>,使血液处于高凝状态; 6. 用药方面,甘露醇是一种高渗性脱水药物,能改善脊柱术后神经根水肿,是脊柱外科最常用的药物,用药后会血液浓缩引起血液高凝状态,除对血管有刺激性外,容易引起静脉炎,增加 DVT 的发病率; 7. 心脑血管疾病、长期吸烟史和肥胖的患者可能增加深静脉血栓的发病率。

### 2 DVT 的风险评估

应用科学有效的血栓风险评估工具,准确评估骨折患者下肢 DVT 的风险,是护士筛选高危人群、实施预防的前提。目前,国际上常用的预测深静脉血栓风险的量表有:Caprini 量表、Autar 量表、Wells 量表、Geneva 量表等。

Caprini 风险评估模型,评估量表共 38 个危险因素,按总分分为低危 0-1 分、中危 2 分、高危 3-4 分、极高危 $\geq 5$  分 4 组,并根据风险分层推荐不同的预防措施。Caprini 风险评估模型有效的基于个体危险因素并量化 DVT 风险进行评估,该量表有较强的适用性,在国内外运用广泛<sup>[7]</sup>。

Autar 血栓风险评估量表由 Autar 于 1996 年设计<sup>[8]</sup>。量表涵盖了年龄、BMI、活动度、特殊风险类、创伤、手术及高风险疾病 7 个危险因素,分别取分值为 1-7 分。无风险 $< 7$  分,低危 7-10 分、中危 11-14 分、高危 $\geq 15$  分 4 个等级。Autar 量表中卧床、具体的活动能力等条目体现了骨科术后患者的特点,且 Autar 量表起源于骨科,在疾病类型和人群方面更有针对性。

Wells 评估风险量表是全球应用最广泛的量表。主要纳入了七个危险因素:既往血栓史、心率、咯血、活动性肿瘤、4 周内的手术或制动史、DVT 症状与体征、除 PE 外的其他诊断。临床诊断的不确定性及主观性会错误估计 DVT 风险,导致其在国内运用并不常见<sup>[9]</sup>。

### 3 DVT 预防的措施

目前,脊柱手术后 DVT 的预防尚无统一标准,各医疗单位也有各自的预防策略。北美脊柱外科协会建议所有脊柱手术后的患者均需采取一定的预防措施,以减少血栓事件的发生。脊柱手术后患者血栓形成的预防主要包括基础预防、机械预防和药物预防。术前可进行基础预防和机械预防,直至病人完全下床。

### 4 基础预防措施

1. 对脊柱手术患者进行健康教育,使患者了解 DVT 的相关因素,从而提高患者的依从性和自我护理的能力;2. 术后患者需要定时行轴式翻身 $\leq 2$  小时/次,双下肢抬高 20-30 度,促进静脉回流;3. 能主动进行双下肢早期功能锻炼的患者,术后麻药清醒后即可指导患者进行双下肢踝泵运动,用力背伸 30° 保持 3-5 秒,然后用力跖曲 45° 保持 3-5 秒,一次做 3-5 分钟,每天 8-10 次,每天 300 个。不能主动活动的患者可在术后当日行被动按摩双下肢比目鱼肌和腓肠肌,也可被动活动踝关节。术后第一天,可在床上进行直腿抬高训练和屈膝运动,运动量不宜过大,以患者不感觉疲劳为宜;4. 早期下床,有文献研究指出,在患者病情允许的情况下,协助患者早期下床可显著降低 DVT 的发生率<sup>[10]</sup>;4. 保护血管:尽量避免下肢输血,必要时避免止血带捆绑时间过长,避免同一部位多次穿刺,防止药物外渗;5. 建议患者改变生活方式,如多喝水,每天饮水 2000 毫升左右,戒烟戒酒;6. 控制血糖血脂。有文献研究报道,糖尿病、高脂血症患者血液处于高凝状态、血脂指标差,下肢深静脉血栓发生率高<sup>[11]</sup>;

### 5 机械预防措施

目前临床用的机械预防措施主要包括间歇性充气压力泵、梯度压力袜和足底静脉泵,这些预防措施可使患者双下肢肌肉收缩,促使血液回流,减缓和防止下肢静脉血液瘀滞,以达到预防和减少 DVT 发生的目的。对于脊柱手术后高危因素少,以及有高出血风险的手术患者,尽量采用机械预防措施来防止 DVT 的发生,而不使用抗凝药物,这样可以降低因使用抗凝药物而导致的潜在出血的风险。研究指出,单纯使用机械措施预防 DVT 时,可将 DVT 形成的风险降低 2/3<sup>[12]</sup>。我国深静脉血栓形成的诊断和治疗指南指出,梯度压力袜和间歇性充气压力泵是预防 DVT 发生和复发的重要措施。间歇性充气压力泵使用前

应选择大小合适的腿套, 评估好双下肢有无伤口, 皮肤破损及血液循环等, 避免造成止血带的作用。目前对于间歇性充气压力泵的使用时间和频次没有具体定论, 在建议每天使用 18 小时, 对于完全不能活动的患者, 应尽量延长时间<sup>[13]</sup>。具体要考虑患者的耐受情况。梯度压力袜要选择合适尺寸, 穿时要拉直脚尖部位使足踝和足背部平整无褶皱, 任何情况下禁忌翻转袜跟折叠压力带, 三角缓冲绷带应位于大腿内侧, 使用期间建议白天与夜间均穿着, 并注意观察肢的血液循环情况, 如皮温, 颜色及足背动脉搏动等。足底静脉泵需要注意压力的调整, 如果压力过高, 很容易造成皮肤挤压伤。如果压力过低, 对一些肌肉功能强的人就不能起到有效的作用, 但在临床实践中却不能达到实验条件下的理想状态。

## 6 药物预防措施

根据 DVT 诊断和治疗指南, 药物治疗是预防深静脉血栓的有效方式。脊柱手术后患者抗凝药物的使用在医学界存在争议。一些专家学者认为脊柱手术后广泛使用抗凝药物可以导致切口出血量增加, 伤口血肿等, 不建议使用抗凝药物, 但是也有学者认为适当使用抗凝药物不会出现上述问题。目前常见的药物分为以下几种:

1、肝素, 主要包括普通肝素和低分子肝素。(1)普通肝素会存在个体差异, 极易引发血小板降低, 所以目前临床上较少用。(2)低分子肝素可根据患者自身状况进行适当的调整, 安全性更高。唐亮<sup>[14]</sup>等学者指出在脊柱手术中充分彻底止血的基础上, 可以采用低分子肝素不会造成椎管内大出血和血肿的风险。

2、阿司匹林该药物是一种抗血小板聚集药物, 可长时间小剂量使用。

3、Xa 因子抑制剂常见药物有利伐沙班, 药物使用个体差异相对较低, 使用剂量固定, 无显著抗血小板功能。治疗安全性较高。

4、维生素 K 拮抗剂此药物需要经常调整药物剂量, 患者依从性较差。

在使用抗凝药物过程中, 应严密监测患者生命体征, 遵医嘱行静脉采血查看有无凝血功能的异常, 观察患者伤口敷料有无渗血, 伤口引流液的颜色、性质以及量, 观察有无牙龈及皮下出血等情况, 发现异常及时通知医生做相应处理。

## 7 出院指导

在患者出院时, 应告知患者继续适度功能锻炼活动, 尽量避免久坐、久蹲以及久站等动作, 并定期到医院门诊复查, 以检验预防措施是否有效, 以便及时改变方案及措施。最后, 还应告知患者下肢 DVT 早期临床症状, 如出现异常, 及时就医。

## 8 小结

脊柱手术后 DVT 的形成是较常见的并发症, 将对患者的生命健康构成重大威胁。然而, DVT 的早期临床症状并不明显, 影响 DVT 的因素很多。但是, 有研究显示, 在临床工作中, 仍存在下肢 DVT 防治规范标准不统一, 相关知识培训不健全, 知识更新不及时等问题。因此临床上应该充分重视, 防重于治, 加强护士对下肢深静脉血栓的认识, 提升风险评估能力, 对患者实施具有预见性、针对性的预防措施, 从而降低下肢深静脉血栓的发生率。目前主要的预防措施有基础预防、机械预防及药物预防, 这些措施在临床应用过程中均取得了显著的效果。

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