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Research progress of lung cancer complicated with pulmonary embolism

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Abstract: Pulmonary embolism and deep venous thrombosis are collectively referred to as venous thromboembolism, while pulmonary embolism is generally caused by deep venous thrombosis and pulmonary embolism, which is sudden and fatal. Lung cancer is the most common cancers, and is also the leading cause of cancer death in men and the second cause of cancer death in women all over the world. Pulmonary embolism is one of the common complications of lung cancer, which will affect the survival time of lung cancer patients and make the symptoms of lung cancer more complex and difficult to distinguish. Correct identification and effective anticoagulation therapy can reduce the mortality of lung cancer complicated with pulmonary embolism. Therefore, it is necessary to review the research progress of lung cancer complicated with pulmonary embolism.

Keywords: Lung cancer; Pulmonary embolism; Deep venous thrombosis; Risk factors

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Venous thromboembolism (VTE) includes deep venous thrombosis (DVT) and pulmonary embolism (PE). PE is the third most common acute cardiovascular syndrome, next only to myocardial infarction and stroke [1], and it is a common complication of lung cancer. The risk of thrombus increases in cancer patients, with lung cancer patients having a 20-fold higher risk of developing VTE compared to the general population [2]. The occurrence of PE in lung cancer patients is associated with mortality, with autopsy reports showing that it accounts for approximately 10% of deaths [3]. It is worth noting that, with the decrease in the total number of autopsies globally, the incidence of PE may be underestimated, especially in lung cancer patients who experience sudden death. Because the symptoms of PE overlap with those of lung cancer, it is often overlooked in clinics. PE can worsen the condition of lung cancer patients and may even lead to sudden death. Surveys have revealed that anticoagulant treatment is significantly associated with improved survival in lung cancer patients not suspected of PE [4]. In recent years, with the continuous exploration and breakthroughs in chemotherapeutic agents, targeted drugs, and immunotherapy, the survival period of cancer patients has significantly improved. Early identification of patients with lung cancer who have concomitant PE and initiate standardized anticoagulant treatment can minimize the morbidity and mortality of PE events. This review mainly focuses on the risk factors and therapeutic advances in lung cancer patients with PE.

1 Pathophysiology of thrombus formation

According to the pathophysiological mechanism, the formation of thrombus is considered to involve the following factors: (1) Vascular endothelial injury: Tumor cells can directly invade blood vessels, causing vascular wall damage, endothelial denudation [5], or direct thrombus formation. Additionally, procedures such as central venous catheterization, surgery, chemotherapy [6], and radiotherapy during tumor treatment can also cause endothelial injury of the blood vessels. (2) Venous stasis: The vascular compression of parenchymal tumor, surgery, prolonged bed rest and reduced physical activities in lung cancer patients with advanced-stage cachexia, can alter venous blood flow, leading to venous stasis. (3) Hypercoagulable state: Studies have found upregulated expression of tissue factors and podoplanin in lung cancer [5], which can initiate the coagulation process and cause coagulation cascades, resulting in a hypercoagulable state. In addition, the immune system is also involved in this process. Some studies have elucidated that exosomes derived from lung cancer cells can activate mast cells [7], and activated mast cells become highly pro-inflammatory and actively recruit immune cells. The inflammatory mediators in mast cell granules can mediate endothelial activation and activate neutrophils to trigger neutrophil extracellular traps, which can act as scaffolds for procoagulant activity [8]. These inflammatory reactions also contribute to hypercoagulability. Moreover, lung cancer patients have shortened blood clotting time, increased levels of fibrinogen, and elevated platelet levels [9], which are important factors contributing to hypercoagulability.

2 Risk factors

The pathomechanism underlying the occurrence of PE in lung cancer patients is complex, and the following will discuss its risk factors from three aspects.

2.1 Patient-related factors

(1) Ethnicity: Studies have shown that the incidence of VTE is lower in Asians and Caucasians compared to black patients [10]. Ethnicity seems to impact the formation of PE in lung cancer patients, possibly related to local economic and medical levels, but there is still a lack of research data, and the mechanism is unclear. (2) Age: The older the age, the higher the incidence of cancer-associated VTE [11-12]. This may be related to underlying diseases and reduced physical activity in elderly patients. (3) Gender: Male patients are more commonly affected by lung cancer with concomitant PE [13], which may be related to a higher incidence of lung cancer in males. However, with the decrease in the number of global smokers, the incidence of lung adenocarcinoma in females is gradually increasing. Currently, there is still a lack of updated relevant researches. (4) Comorbidities: It was found that comorbidities such as anemia, obesity, and chronic obstructive pulmonary disease [12] can increase the risk of thrombus formation. (5) Haematological parameters: Elevated white blood cell count, decreased PaO_2, and elevated D-dimer levels have been reported as independent risk factors for PE formation in lung cancer patients [14].

2.2 Lung cancer-related factors

In terms of the histological type of lung cancer, studies have shown that adenocarcinoma is an independent risk factor for PE [15-16], with a triple risk of VTE compared to squamous cell carcinoma. This may be related to the secretion of procoagulant factors, platelet activation, and the microthrombus formation in the capillary circulation caused by mucins produced by adenocarcinoma cells [17]. Additionally, adenocarcinoma is more prone to metastasis compared to other types of lung cancer [18], which also contributes to thrombus formation. Currently, there is limited research on the mechanisms of PE in squamous cell carcinoma. However, studies have found increased expression of podoplanin in lung squamous cell carcinoma [5, 19]. Podoplanin can induce platelet activation through binding to C-type lectin-like receptor 2, promoting hematogenous cancer metastasis and cancer-associated thrombus formation.

In terms of the genotypes of lung cancer, increasing evidence suggests that the genetic characteristics of lung cancer patients may be associated with VTE. The incidence of VTE is three to five times higher in anaplastic lymphoma kinase (ALK)-positive advanced non-small cell lung cancer patients [20]. This may be due to enhanced tissue factor procoagulant activity, increased mucin richness, and specific binding of extracellular ALK-positive lung cancer cells to heparin, increasing the risk of thrombus formation through the NF-κB signaling pathway[20-21]. In addition, research has found that the incidence of VTE is three to five times higher in advanced non-small cell lung cancer patients with ROS1 rearrangement [22], which may be related to the mucinous characteristics of adenocarcinoma and ultimately lead to systemic platelet activation. Currently, mutations in epidermal growth factor receptor (EGFR) and Kirsten rat sarcoma viral oncogene homolog (KRAS) have not yet been fully confirmed to cause PE. Therefore, D-dimer levels in ALK-positive and ROS1-rearranged lung cancer patients should be monitored more frequently, and computed tomography pulmonary artery (CTPA) should be performed to exclude potential PE if necessary. In future clinical work, the genetic profile of lung cancer patients can be further explored to verify whether it can be incorporated into risk stratification and anticoagulation decision-making for thromboembolism. This would help in the early screening and diagnosis of PE in these patients.

In terms of tumor stage, advanced (stage III/IV) lung cancer at the time of initial diagnosis is an independent risk factor associated with PE [16], and the higher risk of PE in patients with advanced lung cancer compared to stage I/II may be related to the relative shortening of coagulation time and elevated levels of plasminogen activator inhibitor (PAI-1) [9]. This implies that in advanced lung cancer patients, when the disease progresses, the possibility of PE formation needs to be considered in addition to tumor progression.

2.3 Treatment-related factors

Treatment-related factors can also increase the risk of thrombus formation in lung cancer patients. These factors include hospitalization, radiotherapy, surgery, central venous catheters, and anticancer drugs [24]. Among them, surgery is a significant risk factor for PE, even in patients receiving thromboprophylaxis [25]. The risk of developing PE within one month after surgery is 1.3%, and the risk decreases as postoperative time progresses [26]. In addition, an essential mechanism by which chemotherapy drives thrombosis is the toxicity and irritation of chemotherapeutic agents. The endothelium can be directly damaged, and the risk of VTE will increase, especially in the first 3 to 6 months of treatment [6]. Another important mechanism by which chemotherapeutic agents drive thrombus formation may be through the promotion of the coagulation process. Drugs such as cisplatin and carboplatin, in addition to directly damaging the vascular endothelium, can also participate in procoagulant activity and increase procoagulant activity on endothelial cells by TF decryption through a disulfide bond formation in a protein disulfide isomerase (PDI)-dependent mechanism [27]. Additionally, it has been reported that other anti-angiogenic targeted therapies, such as bevacizumab and immune checkpoint inhibitors, may also increase the risk of thrombosis [24, 28]. With the increasing number of anticancer drugs, new issues related to adverse thromboembolic events may continue to emerge, and experiences should be summarized from these cases. Although the above risk factors have been continuously summarized and validated, their underlying mechanisms are still not fully elucidated, and further research is

needed to develop more effective strategies for the prevention and treatment of PE.

3 Identification and diagnosis

Misdiagnosis or missed diagnosis of PE frequently occurs in clinical practice because the clinical symptoms of PE are often difficult to identify. When the original clinical symptoms of lung cancer patients worsen or new symptoms such as dyspnea, chest pain, hemoptysis, restlessness, and decreased blood oxygen saturation, it is necessary to consider tthe possibility of concomitant PE in addition to the tumor progression. D-dimer is a degradation product of cross-linked fibrin produced by fibrinolysis, and it is considered to be a sensitive biomarker for pre-thrombotic or hypercoagulable states. Due to its high negative predictive value for PE, a D-dimer concentration below 0.5 mg/mL is typically used as a necessary criterion to exclude PE [29]. Additionally, CTPA has demonstrated high reliability and safety in diagnosing and localizing PE [30]. PE manifests as filling defective changes within the pulmonary arteries, clearly showing the location of the primary lesion and thrombus. For suspected patients with pulmonary embolism, CTPA can be used as a diagnostic tool when D-dimer levels are elevated. However, CTPA is not suitable for patients with iodine allergies or renal dysfunction. In such cases, pulmonary contrast-enhanced magnetic resonance angiography (MRA) can be used as an effective alternative to CTPA [31].

Furthermore, the Khorana score can help physicians identify high-risk patients for PE and determine whether thromboprophylaxis is necessary. This scoring system stratifies the risk of developing PE during chemotherapy for cancer patients based on tumor type, pre-chemotherapy blood counts, and body mass index [32]. Although the Khorana score is the most extensively validated VTE risk assessment score for cancer patients, it performs poorly in assessing the risk of VTE in lung cancer patients [33-34]. Therefore, a new reference indicators for predicting the occurrence of PE in lung cancer patients is required. Apart from the consensual factors, other risk factors such as histological subtype, genetic characteristics, staging, and the first 6 months of chemotherapy can be considered, as they may help identify which patients may benefit from prophylactic anticoagulation to reduce the morbidity and mortality of PE.

4 Treatment and prevention

Compared to non-cancer patients, cancer patients face a higher risk of VTE recurrence and bleeding associated with anticoagulant therapy [35]. A meta-analysis shows that prophylactic anticoagulant therapy does not improve the prognosis of lung cancer patients and may increase the risk of bleeding [36]. Therefore, anticoagulant treatment for lung cancer patients should be individualized. For years, low-molecular-weight heparin (LMWH) has been recommended as the preferred anticoagulant for treating tumor-related VTE. Many trials have shown that LMWH has greater efficacy in preventing thrombus recurrence and lower bleeding risk compared to vitamin K antagonists such as warfarin [37-38]. According to a guideline from China, patients with tumor-related PE should receive 6-12 months of anticoagulant therapy [39]. Since the use of LMWH for more than 6 months has not been evaluated, when the patient's clinical condition improves, a transition to newer oral anticoagulants can be considered [40]. Studies such as CARAVAGGIO and ADAM have shown that apixaban demonstrates similar efficacy to LMWH and has the best safety profile in terms of bleeding, even in patients with gastrointestinal cancer [41-42]. It is worth noting that although many trials have investigated the optimal prophylactic and therapeutic regimen for PE in lung cancer patients, the safety assessment of newer oral anticoagulants is still limited and further studies are needed.

Additionally, the placement of inferior vena cava filters (IVCF) is a method for preventing the detachment of DVT and the formation of PE. Studies have shown that the placement of IVCF can reduce the incidence of PE in lung cancer patients [43]. However, the most common complication associated with IVCF is the development of new or propagated DVT. Guidelines from the NCCN and ITAC-CME suggest that mechanical thromboprophylaxis should only be used in cases where anticoagulation is contraindicated [44]. Currently, there is still a lack of large-scale cohort studies to clarify the relationship between IVCF placement and mortality [43], and the appropriate use of IVCF in cancer patients is still not meeting clinical needs.

5 Conclusion

In conclusion, PE is a severe complication of lung cancer and the second leading cause of mortality in lung cancer patients. Therefore, the severity of PE, as well as early detection and intervention, should be realized by lung cancer patients in advance. Risk stratification of lung cancer patients based on readily available clinical characteristics and risk factors should be performed, and prolonged prevention and treatment should be ensured to reduce the incidence and mortality of acute PE.

Conflict of Interest None

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· 研究进展 ·

肺癌合并肺栓塞的研究进展

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摘要：肺栓塞和深静脉血栓形成统称为静脉血栓栓塞症，而肺栓塞一般是深静脉血栓脱落栓塞肺动脉所致，具有突发性和致死性的特点。肺癌是最常见的恶性肿瘤，也是全世界男性癌症死亡的主要原因和女性恶性肿瘤死亡的第二位原因。肺栓塞是肺癌常见并发症之一，影响肺癌患者的生存时间，可使肺癌的症状更加复杂和不易区分，正确的识别诊断和有效的抗凝治疗可降低肺癌合并肺栓塞的病死率。因此，本研究对肺癌合并肺栓塞的研究进展作一综述。

关键词：肺癌；肺栓塞；深静脉血栓形成；危险因素

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Research progress of lung cancer complicated with pulmonary embolism

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Abstract: Pulmonary embolism and deep venous thrombosis are collectively referred to as venous thromboembolism, while pulmonary embolism is generally caused by deep venous thrombosis, which has the characteristics of sudden and mortality. Lung cancer is the most common cancer, and is also the leading cause of cancer death in men and the second cause of cancer death in women all over the world. Pulmonary embolism is one of the common complications of lung cancer, which will affect the survival time of lung cancer patients and make the symptoms of lung cancer more complex and difficult to distinguish. Correct identification and effective anticoagulation therapy can reduce the mortality of lung cancer complicated with pulmonary embolism. Therefore, this article is to review the research progress of lung cancer complicated with pulmonary embolism.

Keywords: Lung cancer; Pulmonary embolism; Deep venous thrombosis; Risk factors

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静脉血栓栓塞症(venous thromboembolism, VTE)包括深静脉血栓形成(deep venous thrombosis, DVT)和肺栓塞(pulmonary embolism, PE)，PE 是仅次于心肌梗死和中风的第三大急性心血管综合征[1]，是肺癌常见的并发症。癌症患者发生血栓的风险增加，肺癌患者发生 VTE 的风险比普通人群增加 20 倍[2]，肺癌患者死亡率与 PE 的发生相关，有尸检报告显示约占死亡人数的 10%[3]。值得注意的是，随着全球尸检总数的减少，PE 的发生率可能被低估，尤其是猝死的肺癌患者。PE 与肺癌症状重叠，临床中常被忽略，PE 会加重肺癌患者的病情，甚至可能导致猝死。有研究发现，抗凝治疗与未被怀疑患有 PE 的肺癌患者生存率的提高显著相关[4]。近年来，随着化疗药物、靶向药物、免疫治疗等不断探索及突破，癌症患者的生存期显著提高，早期识别出肺癌合并 PE 的患者，并且尽早规范的抗凝治疗，可最大限度地降低 PE 事件的发病率和死亡率。本综述主要侧重于阐述肺癌患者形成 PE 的危险因素及治疗进展。

1　血栓形成机制

根据病理生理学机制，考虑血栓形成是由以下因素引起。(1) 血管内皮损伤：肿瘤细胞可直接侵入血管，引起血管壁损伤、内皮剥脱[5]或直接形成血栓；另外，肿瘤治疗过程中静脉置管、手术、化疗[6]、放疗等也会引起血管内皮的损伤。(2) 静脉血流淤滞：肿瘤实质的血管压迫、手术，及晚期消耗

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状态的肺癌患者长期卧床、活动减少等均可改变静脉血流状态,导致静脉血流淤滞。(3) 高凝状态:有研究发现,肺癌中组织因子和平足蛋白表达增强[5],会启动凝血过程引起凝血的级联反应,导致高凝;此外,免疫系统也参与了这个过程,有研究发现源自肺癌细胞的外泌体可以激活肥大细胞[7],活化的肥大细胞变得高度促炎并积极募集免疫细胞,其富含的促炎介质颗粒,可介导内皮激活,还可以激活中性粒细胞触发中性粒细胞外陷阱——可充当促凝血剂的支架,这些炎症反应也是导致高凝的重要因素[8]。另外,肺癌患者的血凝块形成时间缩短,纤维蛋白原、血小板水平升高也是导致高凝状态的重要原因[9]。

2　危险因素

肺癌患者发生 PE 的机制复杂,以下将从三方面来阐述其危险因素。

2.1　*患者相关因素*　(1) 种族:有研究表明,与黑人患者相比,亚洲人及白种人的 VTE 发生率较低[10],种族似乎对肺癌患者形成 PE 存在某种影响,可能与当地经济、医疗水平相关,但仍缺少研究数据,其机制尚不明确。(2) 年龄:年龄越大,癌症相关的 VTE 发生率越高[11-12],这可能与老年患者的基础疾病、活动减少等因素相关。(3) 性别:肺癌合并 PE 在男性中更常见[13],可能是男性肺癌的发病率更高,但随着全球吸烟人数的减少,女性在腺癌中的发病率逐渐升高,目前仍缺少最新的相关研究。(4) 合并症:有研究发现,贫血、肥胖、慢性阻塞性肺疾病等[13]合并症也会增加血栓形成的风险。(5) 血液参数:据报道,白细胞升高、动脉血氧分压下降和 D-二聚体升高是肺癌患者形成 PE 的独立危险因素[14]。

2.2　*肺癌相关因素*　就肺癌的病理类型而言,已有研究表明,腺癌是 PE 的独立危险因素[15-16],腺癌发生 VTE 的风险比鳞状细胞癌(鳞癌)高 3 倍,这可能与该组织学类型产生的黏蛋白导致促凝血因子的分泌,血小板激活和毛细血管循环中微血栓的形成有关[17];此外,腺癌与其他类型的肺癌相比更容易转移[18],这也有助于解释血栓的形成。目前,单独分析肺鳞癌合并 PE 机制的研究较少,有研究发现平足蛋白在肺鳞癌中表达增加[5,19],其可通过 C 型凝集样受体 2 结合诱导血小板活化,并促进血源性癌症转移和癌症相关血栓形成。

就肺癌的基因类型而言,越来越多的证据表明,肺癌患者的基因特征可能与 VTE 存在某种关联。研究发现晚期间变性淋巴瘤激酶(ALK)阳性的非小细胞肺癌患者中,VTE 的发生率比普通患者高 3~5 倍[20],其机制可能是通过 NF-κB 信号通路增强组织因子促凝活性、增加黏蛋白丰富度、ALK 阳性的肺癌患者胞外区与肝素特异结合等方式增加血栓形成的风险[20-21]。另外,有研究发现晚期非小细胞肺癌中,C-ros 原癌基因 1-受体酪氨酸激酶(ROS1)-重排患者较非重排患者的 VTE 发生率高 3~5 倍[22],这可能与腺癌的黏液特质相关[23],最终导致血小板的全身性激活。目前表皮生长因子受体(EGFR)及 Kiresten 大鼠肉瘤病毒癌基因(KRAS)突变与 PE 发生尚未得到充分证实。因此,对于 ALK 阳性和 ROS1-重排的肺癌患者应更频繁地监测 D-二聚体水平,必要时行 CT 肺动脉造影(computed tomography pulmonary artery, CTPA)以排除潜在的 PE。在将来的临床工作中可进一步探讨肺癌患者的基因特征是否可以纳入栓塞风险分层和抗凝决策,以利于早期对这类患者进行 PE 的筛查、诊断。

就肿瘤分期而言,初诊时的晚期(Ⅲ/Ⅳ期)肺癌是 PE 相关的独立危险因素[16],与Ⅰ/Ⅱ期相比,晚期肺癌患者发生 PE 的风险较高,可能与凝血时间相对缩短和纤溶酶原激活物抑制物(PAI-1)水平升高有关[9],这意味着当晚期肺癌患者疾病进展时,除了考虑肿瘤进展还需考虑 PE 形成的可能。

2.3　*治疗相关因素*　治疗相关因素也会增加肺癌患者血栓形成的风险,包括住院、放疗、手术、中心静脉导管和抗癌药物等[24]。其中,手术是 PE 的重要危险因素,即使在接受抗血栓预防的患者中,PE 的风险也很大[25]。术后 1 个月内发生 PE 的风险为 1.3%,并随着术后时间的推移,PE 的风险也会随之下降[26]。其次,化学治疗驱动血栓形成的一个重要机制是化疗药物的毒性和刺激性,会直接损伤内皮,增加 VTE 事件的风险,特别是在治疗的前 3~6 个月[6];另一个重要机制可能是化疗药物可能会促进凝血过程,如顺铂、卡铂等药物,除直接损伤血管内皮外,还可以通过依赖蛋白质二硫键异构酶中的二硫键形成机制,参与组织因子的激活,增加促凝血活性[27]。此外,有报道称其他抗血管靶向药物如贝伐单抗、免疫检查点抑制剂可能也会增加血栓的风险[24,28]。随着抗癌药物种类的增加,抗肿瘤药物相关不良血栓栓塞事件的新问题可能会不断出现,需从中总结经验。尽管以上危险因素已经被不断总结和验证,但其潜在的机制仍未完全阐明,仍需进一步探讨,以研究出更有效预防和治疗 PE 的策略。

3　识别与诊断

PE 的误诊或漏诊在临床工作中经常发生,因为 PE 的临床症状通常不易识别,当肺癌患者原有的临床症状加重或新出现呼吸急促、胸痛、咯血、情绪不安、血氧饱和度下降等临床表现时,除了考虑肿瘤进展还需要排除合并 PE。D-二聚体是交联纤维蛋白在纤溶酶作用下产生的降解产物, 被认为是血栓前或高凝状态的敏感标志物之一,由于其对 PE 的阴性预测值较高,当其浓度低于 0.5 mg/mL 时,通常可作为排除 PE 的必要标准[29]。另外, CTPA 在诊断和定位 PE 方面表现出了高度的可靠性和安全性[30],PE 表现为肺动脉内充盈缺损性改变,可以清楚地显示原发灶和栓子的位置。对可疑 PE 患者,当 D-二聚体升高时,CTPA 检查可作为诊断 PE 的依据。但是,对碘过敏、肾功能衰竭等不适合做 CTPA 检查者,肺对比增强磁共振血管成像可作为 CTPA 的有效替代检查[31]。

此外,Khorana 评分可以帮助医生识别出 PE 高风险患者,并决定是否进行血栓预防。这项评分根据肿瘤类型、化疗前血液计数和身体质量指数对癌症患者在化疗期间发生 PE 的风险进行分层[32],作为癌症患者最广泛验证的 VTE 风险评估评分,Khorana 评分在肺癌患者 VTE 风险评估中表现不佳[33-34],因此,可以寻找预测肺癌患者发生 PE 的新的参考指

标。除了共认的因素外,还可以考虑其他危险因素,如腺癌亚型、基因特征、分期和化疗前 6 个月等,有助于确定哪些患者可能受益于预防性抗凝,从而降低 PE 的发病率和死亡率。

4　治疗与预防

与非癌症患者相比,癌症患者面临更高的 VTE 复发和与抗凝治疗相关的出血风险[35]。一项 Meta 分析显示,预防性抗凝治疗并不能改善肺癌患者的预后,反而会增加出血风险,因此,肺癌患者的抗凝治疗应个体化[36]。数年来,低分子肝素一直是治疗肿瘤相关 VTE 的推荐抗凝药物。许多试验表明,与华法林等维生素 K 拮抗剂相比,低分子肝素在预防血栓复发方面具有更大的疗效,且出血风险更低[37-38]。根据国内 2019 年版的指南推荐,肿瘤合并 PE 患者要接受 6~12 个月的抗凝治疗[39],由于未评估过使用时间超过 6 个月的低分子肝素,当患者的临床状况改善时,可考虑过渡为新型口服抗凝药[40]。CARAVAGGIO和 ADAM 研究表明阿哌沙班与低分子肝素有类似疗效且出血方面安全性最好,即使在胃肠道癌症患者中也是如此[41-42]。值得注意的是,虽然很多实验研究了肺癌患者 PE 最佳预防和治疗方案,但对新型口服抗凝药的安全性的评估也很有限,还需进一步研究。

另外,放置下腔静脉滤器(inferior vena caval filter, IVCF)是一种预防 DVT 脱落形成 PE 的方法。有研究表明,IVCF 的放置能够减少如肺癌患者 PE 的发生[43]。但是 ICVF 相关的最常见的并发症是发展新的 DVT 或传播现有的 DVT,美国国立综合癌症网络及国际血栓形成与癌症倡议的指南建议,只在有抗凝禁忌证的情况下才建议使用机械血栓预防[44]。目前,仍缺少大规模的研究来说明放置 IVCF 与死亡率的关系[43],ICVF 在癌症患者中的适当使用仍然未满足临床需求。

5　小　结

PE 是肺癌的严重并发症,也是肺癌患者第二常见的死亡原因。因此,对于肺癌患者,应该提前意识到 PE 的严重性以及做到早发现、早干预。应根据临床特征、危险因素对肺癌患者进行风险分层,并保证对患者进行更长时间的预防和治疗以降低急性 PE 的发生率和病死率。

利益冲突　无

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