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ORIGINAL

EFFICACY ANALYSIS OF LOW-DOSE ALTEPLASE AND STANDARD-DOSE ALTEPLASE IN THE TREATMENT OF ACUTE PULMONARY EMBOLISM WITH THROMBOLYTIC THERAPY IN MUSCULOSKELETAL INJURY ATHLETIC PATIENTS

Bo Li, Xue Li, Jiali Wu, Lishan Yang*

[1]Emergency Department, General Hospital of Ningxia Medical University, Ningxia, 750001, China.
E-mail: nyfyyls@163.com

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ABSTRACT

Acute pulmonary embolism (APE) is a critical condition characterized by high mortality and morbidity, primarily caused by the obstruction of pulmonary artery vessels due to various types of emboli such as blood clots, fat droplets, air bubbles, intravenous drug particles, and amniotic fluid. The resultant blockage leads to cardiac insufficiency and significant respiratory symptoms. In athletes, particularly those with musculoskeletal injuries, the management of APE poses unique challenges due to their specific physiological and health requirements. This study specifically focuses on the efficacy analysis of low-dose and standard-dose alteplase in the thrombolytic treatment of APE in athletic patients with musculoskeletal injuries. Alteplase, a tissue plasminogen activator, plays a crucial role in dissolving the obstructive clots in the pulmonary artery, thereby alleviating the symptoms of pulmonary thromboembolism (PTE) – a condition marked by the obstruction of the pulmonary artery or its branches by a thrombus originating from the venous system or the right heart, leading to compromised pulmonary circulation and respiratory dysfunction. The investigation revolves around comparing the effects of low-dose and standard-dose alteplase, considering both the efficacy in resolving pulmonary emboli and the safety profile, which is particularly pertinent in athletes who are prone to bleeding due to musculoskeletal injuries. The study aims to provide insights into the optimal thrombolytic therapy for athletic patients, balancing the urgent need for effective clot dissolution with the risk of exacerbating injury-related complications. This research is pivotal in guiding the treatment protocols for

acute pulmonary embolism in a specialized cohort of patients, enhancing both their immediate and long-term health outcomes.

KEYWORDS: alteplase; Acute pulmonary embolism; Thrombolytic therapy; Curative effect.

1. INTRODUCTION

The incidence of pulmonary embolism in the United States is approximately 1.0% in inpatients and 0.1% in outpatients (Schneider, Lilienfeld, & Im, 2006). The mortality rate of untreated pulmonary embolism is statistically 3 0% and decreases to 8% for those with a clear diagnosis and treatment (Liao et al., 2014). Therefore, P T E has become a common disease and the awareness and treatment of pulmonary embolism needs to be enhanced. Pulmonary embolism and deep venous thrombosis (DVT) of the lower extremities are two common thromboembolic diseases, and APE is often associated with DVT of the lower extremities. Pulmonary examination has been reported to reveal pulmonary embolism in 5% of athletic patients with newly formed D V T and a history of D V T in 70% of patients with pulmonary embolism (Lee et al., 2006; Rathbun, 2009). Because of the close association between the two, when a history of one disease is found to be alert to the possibility of both coexisting and needs to be excluded. Therefore, when patient patients are suspected of having pulmonary embolism, it has even been suggested whether it is possible to check the lower limb vascular ultrasound and give anticoagulation once there, to replace the radiological examination, reduce radiological damage and improve compliance. We know that in 1856 Virchow proposed three basic elements of thrombosis, including slow blood flow, vascular wall damage and blood hypercoagulability, which lead to thrombosis through these three mechanisms. Numerous other factors ultimately activate the above mechanisms leading to thrombosis. The major risk factors for pulmonary embolism include age, surgery, pregnancy and postpartum, trauma, prolonged bed rest, cancer, obesity, hormone therapy, and susceptibility to testing, each of which has been studied more extensively. We need to be aware of the possibility of pulmonary embolism when athletic patients have high-risk factors, but not all high-risk factors necessarily lead to pulmonary embolism. For example, athletic patients with a clear history of cancer are in a hypercoagulable state, and the endothelial damage caused by systemic intravenous chemotherapy and prolonged bed rest are more likely to lead to thrombosis, which can easily develop into pulmonary embolism. At the same time, we need to pay attention to check the possibility of easy embolism, such as hereditary easy embolism, and if conditions allow, we can routinely check protein S, protein C and other indicators. A domestic survey showed that the incidence of anticoagulant protein abnormalities in Chinese athletic patients with deep vein thromboembolism was highest in PS deficiency (1 4.9%), followed by PC (9.2%), and lowest in antithrombin III deficiency (Konstantinides

et al., 2015). The clinical manifestations of pulmonary embolism are diverse, the most common ones being chest pain, coughing up blood, and dyspnea; however, we have no clear evidence to support the specificity of symptoms in patients with pulmonary embolism. The typical triad of symptoms is also rarely seen, with most presenting only one symptom or other complications. Therefore, greater vigilance is needed to prevent missed diagnosis in atypical athletic patients. The mean delay in diagnosis in athletic patients with PE was 7 d, with more than 7 d in 1 8% of cases and more than 35 d in 6% of cases. PE can present acutely with symptoms or can occur in athletic patients with prolonged respiratory symptoms, while hypotension, respiratory rate accelerated all contribute to the early diagnosis of P E. Therefore, understanding these high-risk factors and the clinical manifestations of athletic patients can help in the diagnosis and prevention of pulmonary embolism (Gunn, 2019; Members et al., 2008).

When pulmonary embolism is suspected, there are many tests that can be performed to exclude it, such as D-dimer, electrocardiogram, and echocardiography. The diagnosis of pulmonary embolism is now confirmed by CT pulmonary arteriography (CTPA) and also by pulmonary ventilation perfusion scan (SPECT). As a result of the disease characteristics of pulmonary embolism, there are corresponding changes in ECG, echocardiography, and D-dimer. Athletic Patients with right ventricular insufficiency present with right ventricular enlargement and even elevated cardiac enzymes. Nowadays, the risk stratification of pulmonary embolism is also based on athletic patients' clinical manifestations, echocardiography and cardiac enzymes. We know that the clinical manifestations of athletic patients and abnormalities of cardiac enzymes have a guiding significance in the evaluation of the risk of death, and some studies have shown that right heart insufficiency obtained by chest CT has a correlation with the risk of death in athletic patients with pulmonary embolism and may be partially helpful for risk stratification (Li et al., 2013).D-dimer as a thrombus lysis product has been studied to confirm its value in pulmonary embolism as an important indicator. However, D-dimer determination is still only used as a primary hoof indicator of pulmonary embolism and still requires CTPA and SPECT for definitive exclusion diagnosis (Wang et al., 2010). Blood gas analysis may show hypoxemia and hypocapnia in athletic patients, and these ancillary tests help to determine the possibility of pulmonary embolism and to perform confirmatory tests when necessary.

More guidelines give recommendations for the treatment of pulmonary embolism for clinical application. Anticoagulation is given to athletic patients in the low- to intermediate-risk group, with normal heparin (UFH) or low-molecular heparin (LMWA) given early to stabilize the thrombus and reduce de novo thrombosis, followed by oral anticoagulation for 3 months or longer (Sors et al., 1994). In athletic patients with shock and hypotension, anticoagulation alone does not resolve the acute pathophysiological changes, so thrombolytic therapy

is required. Thrombolytic therapy can reduce the binding of thrombus to fibrin and potentially accelerate thrombus lysis, thus improving the blood flow status and cardiopulmonary function. There are of course interventional and surgical treatments. Thrombolytic therapy in hemodynamically stable athletic patients, reducing their mortality is not proven, but in one study it was found to reduce mortality in patients with massive pulmonary embolism (G Agnelli, Iorio, Parise, Goldhaber, & Levine, 1997). Thrombolytic therapy is best in the early 4 8 h or when the athletic patient is symptomatic, but remains effective in athletic patients 6-14 days after the onset of symptoms (Verstraete et al., 1988). Therefore, proper evaluation should be done, and thrombolytic therapy should be given promptly to athletic patients who are hemodynamically unstable, and athletic patients whose symptoms are still stable should be closely observed for changes in their condition.

Urokinase (UK), streptokinase (SK), and human recombinant fibrinogen activator (rt-PA) are the main drugs used for thrombolysis, and their efficacy has been confirmed in a number of studies. Goldhaber et al. have done a series of studies on thrombolysis in acute pulmonary embolism, confirming the efficacy of UK and rt-PA, and comparing the dose, timing, route and specific implementation methods of the drugs, so that the treatment tends to be standardized. Standardization, the current foreign guidelines recommend the application of rt-PA lOOm g/2h injection. Domestic Professor Wang Chen and other organizations of a large study, that 50mg can receive both good efficacy, but also reduce the risk of bleeding. Therefore, the clinical application of low-dose rt-PA thrombolysis was started in China. The risk of bleeding must be considered for thrombolysis, so athletic patients with bleeding risk are contraindicated for thrombolysis. The most serious bleeding caused by thrombolysis is intra-Lu Page bleeding and visceral bleeding. Major bleeding has been reported in 13% of athletic patients, while fatal bleeding has been reported in 1.8% of athletic patients. Recent analysis of the literature has shown that for low-dose rt-PA lysis treatment can be received with good efficacy and reduced risk of bleeding. Low-dose rt-PA reduces the risk of bleeding, but also faces the possibility of initial treatment, which is not effective, and the need for secondary thrombolysis. However, in such cases thrombolysis can be given again or other appropriate methods of treatment can be chosen, depending on the athletic patient's condition. Of course, time is the only test of truth, and with the increase of clinical practice, we will find a more athletic patient-friendly application of rt-PA.

Thrombolytic therapy is an important treatment for pulmonary embolism in large or high-risk groups. rt-PA application methods are not yet consistent at home and abroad, but it is reasonable to adjust the application method appropriately according to the athletic patient's specific situation as long as the same effect can be received. Starting from a low dose, if no significant improvement in symptoms is seen, thrombolytic therapy can continue to be

administered. The efficacy of thrombolytic therapy has not been confirmed by large-scale studies and remains somewhat controversial (Goldhaber, Agnelli, & Levine, 1994; Sharifi, Bay, Skrocki, Rahimi, & Mehdipour, 2013). In some large data analysis showed that thrombolysis is common in the treatment of acute pulmonary embolism, but the mortality rate is higher with thrombolysis than with anticoagulation alone and the risk of major bleeding is uncommon (Falkowski, Poncyljusz, Samad, & Mokrzyński, 2013).

Thrombolytic therapy is important for athletic patients with massive pulmonary embolism to resolve their acute pulmonary artery obstruction, and although some studies suggest that thrombolytic therapy is higher than anticoagulated athletic patients in terms of mortality, etc., more large, randomized controlled studies are needed to confirm this (Goldhaber, Feldstein, & Sors, 1994). However, as our understanding of pulmonary embolism and research progresses, thrombolytic therapy will become safer. For example, the methods and modalities of thrombolysis with rt-PA are being updated. At this stage, there is no uniform standard for the use of alteplase dose in the treatment of acute cerebral infarction in China, and it is mostly used empirically by clinicians according to the athletic patient's age, onset time, and underlying disease conditions, etc. To explore the best dose of alteplase in China, Qiu Hongyan et al investigated the effectiveness and They concluded that there was no statistically significant difference in the proportion of good prognosis and mortality at 90 d between the non-standard dose group and the standard dose group, and that the optimal dose dose for the Chinese population may be between 0.6-0.9 mg/kg, with 0.7 mg/kg being more consistent according to the median principle, but the sample size of this study was too small and all were from the same stroke center, which also has some limitations. In this study, two cases were selected for thrombolytic therapy using alteplase treatment without dose, and both were successfully treated and analyzed and reported according to clinical efficacy.

2. Case information

2.1 Case 1

Female Athletic Patient, 36 years old, presented with "26+3 weeks of menopause, 6 days of headache and 1 day of stillbirth." She was admitted to the obstetrics department on April 18, 2019. Because of the high risk of bleeding for induction of labor due to placenta praevia, uterine artery embolization was performed yesterday and postoperative intrauterine injection of drugs for induction of labor was performed. At 21:00 today, after the female patient was released from the brake, he suddenly felt chest tightness and shortness of breath, and during the change of position, he suddenly lost consciousness, closed his teeth, turned his eyes upward, and became incontinent, which lasted for about 45 seconds and then recovered by himself. The female patient

complained of chest tightness and shortness of breath with dizziness and weakness, and the timely cardiac monitoring indicated blood pressure of 70/40 mmHg, heart rate of 138 beats/min, oxygen saturation of 95%. He was treated with hydroxyethyl amylase expansion and dobutamine pumping to raise blood pressure, and his blood pressure was measured again at 117/80 mmHg and heart rate at 148 beats/min. Laboratory tests showed that D-dimer was elevated. Combined with the fact that the athletic patient was pregnant, and her body was in a hypercoagulable state, the athletic patient was considered to have a high probability of pulmonary embolism due to today's syncope and hypotension, and was transferred to our department for further intensive monitoring and treatment. The athletic patient was transferred to our department for further intensive monitoring and treatment. After the transfer, we considered the possibility of pulmonary embolism with the athletic patient's medical history and auxiliary examination and informed the athletic patient's family of the related risks.

The athletic patient's body temperature was 36.6℃, pulse rate was 140 beats/min, blood pressure was 132/81mmHg, transcutaneous oxygen and 100 percent (3l/min of oxygen by face mask), mental clarity, poor mental health, bilateral pupils were equal in size and round, diameter was about 2.5mm, responsive to light, neck was soft, no resistance. The thorax was symmetrical, no chest walls pressure pain, coarse respiratory sounds in both lungs, no dry and wet rales were heard. The abdomen was bulging, soft, with positive lower abdominal pressure pain, no rebound pain, and normal bowel sounds. The extremities moved freely. Knee reflex was normal, uterine height was 16 cm, abdominal circumference was 96 cm, and there was no abnormality in internal and external pelvic measurements. Negative examination: negative examination was not performed because the pregnant woman was in placenta previa.

Transfer diagnosis: 1. acute pulmonary embolism 2. severe preterm pre-eclampsia; 2. stillbirth after induction of labor; 3. G2P1 26+3 weeks' gestational status; 4. placenta previa status; 5. combined anemia of pregnancy (mild); 6. uterine artery embolization; 7. gallbladder stone. Transfer precautions and treatment: 1. The diagnosis of acute pulmonary embolism is clear at present, with double pulmonary trunks, and there is always the possibility of pulmonary infarction, respiratory failure, obstructive shock, platelet hypoplasia, electrolyte disorders, coagulation abnormalities, and even respiratory and cardiac arrest and death, etc. Non-invasive ventilator-assisted respiration is needed at any time, and if necessary, transoral tracheal intubation is connected to ventilator-assisted respiration. 2. For pulmonary embolism currently critical life Anticoagulation therapy is needed, but because the athletic patient was induced, the time is short, the stillborn fetus and placenta are not delivered for the time being, and the placenta is anterior, the risk of bleeding is extremely high, and there is always the possibility of uterine haemorrhage, haemorrhagic shock,

etc., and it is difficult to stop bleeding and life-threatening. Please consult with respiratory medicine and obstetrics to help evaluate the current anticoagulation treatment plan.3. The athletic patient has intrauterine stillbirth and may have uterine bleeding and infection, so emergency surgery is needed if necessary. accidents, pulmonary edema, liver and kidney and other multi-organ function damage, failure, sudden death HELLP syndrome, DIC, retinal detachment, blindness, placental abruption, etc., others. If placenta abruptio is present, it may lead to hemorrhagic anemia, hemorrhagic shock, DIC, multi-organ failure, etc. If necessary, blood transfusion is required, emergency cesarean section is needed, and in critical cases, hysterectomy is required resulting in permanent loss of reproductive function. The athletic patient's family was informed in detail of the above condition, and they expressed their understanding of the condition and requested active resuscitation treatment. The athletic patient was closely observed for changes in her condition.The patient showed obvious shortness of breath, indifference, general sweating, blood pressure dropped to about 80/50mmHg at about 16:25, examination showed pale lid conjunctiva, cold extremities, consider pulmonary embolism and right atrial thrombus caused obstructive shock, but do not exclude the patient placental abruption hemorrhagic shock, emergency blood gas analysis suggests metabolic acidosis, actively give sodium bicarbonate to correct acidosis, rehydration, desmethyl The athletic patient was given sodium bicarbonate to correct acidosis, rehydration, norepinephrine pumping to maintain blood pressure, low molecular heparin calcium 4000iu anticoagulation, and application of isotonic red blood cell suspension and plasma. We explained to the athletic patient's family that the athletic patient's circulation was unstable and thrombolysis was urgently needed, but thrombolysis might cause sudden death by embolism, obstetric hemorrhage, intracranial hemorrhage, abdominal hemorrhage, etc. There were therapeutic contradictions. After 2h thrombolysis, the athletic patient's stridor was relieved, blood pressure rose to 110/70 mm Hg, SpO2 95%, heart rate 96 beats/min, and the ECG and bedside echocardiogram returned to normal. The athletic patient was discharged after continuing anticoagulation therapy with low molecular heparin.See Figure 1 and for specific imaging data of pulmonary embolism.

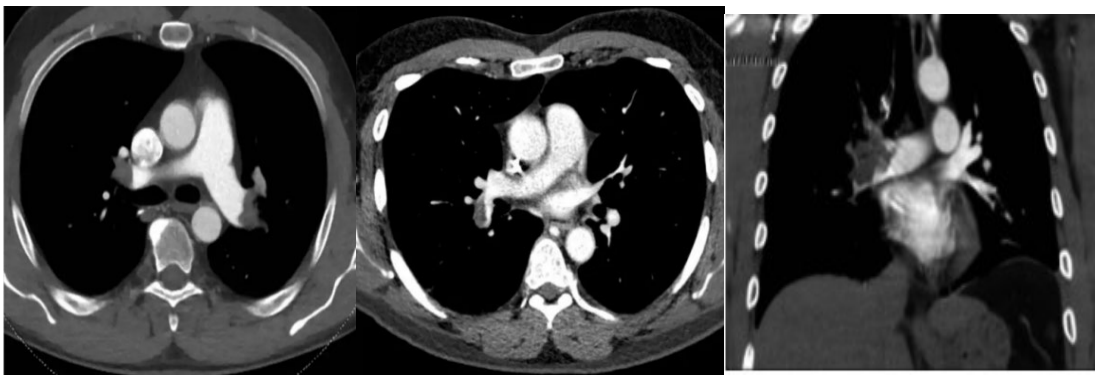

Figure 1: Imaging of pulmonary embolism

2.2 Case 2

The female athletic patient, female, 85 years old, weighing 48 kg, was admitted to the hospital on December 3, 2019 due to "dyspnea after activity for 1 d". The athletic patient suddenly felt dyspnea at 15:00 on December 2, 2019 when she woke up from a nap, and her symptoms of activity were more obvious, without obvious cough, coughing sputum, hemoptysis, chest pain, syncope, fever, etc. Neither the athletic patient nor her family paid attention to it. Past medical history: in 2013, he was hospitalized in our hospital due to chest pain, diagnosed with coronary heart disease and acute myocardial infarction, treated with coronary stent implantation, and stopped taking antiplatelet drugs after 2 years after the operation; he had a history of hypertension for more than 10 years, with the highest blood pressure reaching 180/100mmHg, and in the past 6 months, he did not take antihypertensive drugs, and his systolic blood pressure was maintained at a level of about 140mmHg; in 2013, he underwent minimally invasive In 2013, he underwent a minimally invasive bone cement filling for a lumbar fracture; on November 15, 2019, he accidentally fell and injured his waist, and there was no obvious fracture in the external examination, and he has been resting at home mainly in bed. Emergency physical examination: T36.5℃, R 24 times/min, HR 140 times/min, BP 114/72mmHg, clear consciousness, acute face, lying position, slightly filled jugular veins, clear respiratory sounds in both lungs, no obvious dry and wet rales were heard, atrial fibrillation rhythm, no obvious murmurs, soft abdomen, no pressure pain, mild symmetrical depressed edema in both lower limbs. Emergency examination of blood routine, coagulation function, renal function, electrolytes were normal; serum troponin I (cnI) 0.14n/ml, NT_pm phenol old 6 680ng/L, D dimer 14 400ng/mL; blood gas analysis (nasal catheter oxygen 3L/rnin) PH 7.49, PCO_2 28mmHg, PO_2 70mmHg, SO^2 c 96%, HC03 -21.3 mmol/L, Lac2.5 mmol/L; ECG: atrial fibrillation with rapid ventricular rate. The athletic patient was admitted to the hospital with respiratory distress, recently bedridden for a long time, no retching in the lungs on physical examination, NT-proBNP and D-dimer were significantly elevated, so acute PTE was highly suspected. emergency pulmonary enhancement CT was performed immediately (see Figure 1): multiple thrombosis of the right pulmonary artery trunk, main trunk and branches of both upper pulmonary arteries, right lower lung inflammation, and bilateral pleural thickening. The emergency diagnosis was: acute PTE (medium-high risk), coronary artery disease, post-PCI for myocardial ischemia, atrial fibrillation, cardiac function grade III, and hypertension grade 1 (very high-risk group), and he was admitted to the EICU for further treatment. After the patient was admitted to the EICU, he was given electrocardiographic monitoring, nasal catheter oxygen, and enoxaparin 4O00iu subcutaneously (Q12h). Atherosclerosis, abdominal ultrasound: no significant abnormalities in the liver, bile, spleen and pancreas. December 3, 2019 at 19:30 the athletic patient suddenly became irritable, complained of burning-like pain in the chest and back, physical examination: R25 times/min, HR51 times/min, BP82/51mmHg,

clear, acute face, clear breath sounds in both lungs, no obvious dry and wet rales, atrial fibrillation rhythm, no obvious murmurs, slightly hypotonic heart sounds. The abdomen was soft and without pressure pain. The blood gas analysis was repeated (nasal catheter oxygen 3L/min): PH 7.47, PCO 230mmHg, P0265mmHg, S02c 93%, HCO_3 16.0mmol/L, Lac 5.6mmol/L. The electrocardiogram was repeated: bradycardia, junctional rhythm, anterior wall T wave inversion. Firstly, meprobamate was temporarily given intravenous pumping to raise blood pressure, while the athletic patient was quickly re-evaluated and considered to be in acute PTE with obstructive shock with indication for thrombolysis, and thrombolysis was performed after the athletic patient's family signed consent. on December 3, 2019 at 21:10, alteplase 0.9mg/kg was administered, the maximum dose was 90mg, all athletic patients were sedated within 1min with 10% of the total dose, the remaining 90% into Thrombolysis was performed in 50 ml of physiological saline using an infusion pump within 60 min, and thrombolysis was performed for 2 h. After 20 min of thrombolysis, the athletic patient's chest and back pain symptoms improved significantly; after 1 h of thrombolysis, the athletic patient's heart rate returned to 82 beats/min, and blood pressure returned to maintain around 120/70 mmHg level; the electrocardiogram was reviewed: sinus rhythm, first-degree atrioventricular block; on December 3, 2019 at 23 On December 4, 2019, enoxaparin 4000iu was continued subcutaneously (Q12h).2()On December 10, 19, the pulmonary CTA was reviewed: the right pulmonary artery trunk, main trunk and branches of both upper pulmonary arteries were improved with multiple thrombi, and some thrombi in the right pulmonary artery trunk and both lower pulmonary arteries remained. Residual. discharged on 11 Feb 2019, continued oral rivaroxaban anticoagulation. followed up by phone on 25 Dec 2019, the athletic patient is now continuing to take rivaroxaban anticoagulation and can take care of himself. Figure 2 and for specific imaging data of pulmonary embolism.

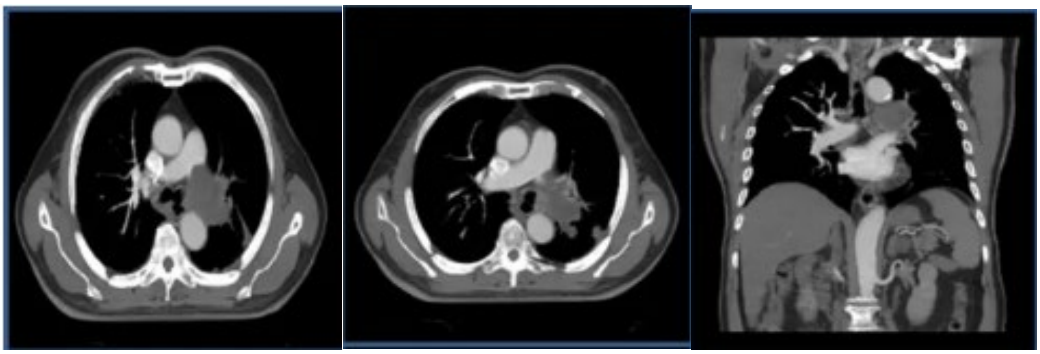

Figure 2: Imaging of pulmonary embolism

3. Discussion

The treatment of pulmonary thromboembolism varies according to the severity of the disease, and thrombolytic therapy is mostly used in athletic

patients with large acute pulmonary thromboembolism and hypotension or hemodynamic changes. However, thrombolysis treatment needs to be individualized, and the time window for thrombolysis is usually set within 14 days, and thrombolysis should be started as soon as possible for those with indications for thrombolysis.

Thrombolysis-related drugs can promote the activation of fibrinogen, which can convert fibrinolytic enzyme to fibrinolytic enzyme, resulting in the dissolution, reduction or elimination of intravascular and intracorporeal emboli, thus improving hemodynamics and pulmonary ventilation and reducing the risk of death. Thrombolysis is generally indicated in athletic patients with acute massive pulmonary embolism, hypotension, or embolism occurring within 5 d. If the embolism is too long, the efficacy of thrombolysis will be significantly reduced because the human fibrinogen has basically been eliminated. In this case, placental fibrinogen 150 mg can be infused before thrombolysis, so that the effect of the thrombolytic drug can be more effective. Thrombolysis is not feasible in all patients, and contraindications to thrombolysis include recent spontaneous intracranial hemorrhage and active bleeding from other parts of the body.

Relative contraindications include a history of surgery or major trauma within 2 weeks, ischemic stroke within the last 2 months, pathologic biopsy within 10 d, or for those with hypertension, atrial fibrillation, subacute infective endocarditis, liver and kidney disease, peptic ulcer, and bleeding constitution (Giancarlo Agnelli & Parise, 1992). Nowadays, there are three types of thrombolytic drugs commonly used by clinicians (Penny & Ware, 1992): 1. Streptokinase (SK): it is a bacterial protein isolated and purified from group C type 1 hemolytic streptococci, which can convert the emboli and fibrinogen in the body into fibrinolytic enzyme, which has strong fibrinolytic activity and thus has a thrombolytic effect, but streptokinase has strong antigenicity and can cause serious allergic reactions, and in addition, because it 2 (Jaff et al., 2011; Sun et al., 2016).

Urokinase (UK): obtained from human urine or cultured human embryonic kidney tissue, its antigenic and toxic reactions are small, and its mechanism of effect is to directly transform fibrinogen into fibrinolytic enzymes for thrombolytic function; 3. recombinant tissue-type fibrinogen activator alteplase (rt-PA) as a new type of thrombolytic agent. rt-PA is a new type of thrombolytic agent, which is a genetic engineering product without antigenicity, and it has strong specificity to fibrinogen, so that it can contact fibrin on the surface of blood embolus, thus activating the local fibrinogen of blood embolus and turning it into fibrinolytic enzyme to dissolve the local thrombus. rt-PA is a new generation thrombolytic agent identical to the naturally secreted tissue-type fibrinogen activator (t-PA). t-PA is synthesized in vivo mainly by endothelial cells of blood vessels and then released into the circulatory system

(Ramakrishnan, 2007).

As a physiological thrombolytic agent, it can be used to prevent thrombus formation and thrombus expansion. rt-PA is one of the most commonly used thrombolytic agents in clinical practice. rt-PA theoretically acts only locally in thrombi, but in practice, even though rt-PA is highly selective, it causes systemic hyperfibrinolysis, moderate degradation of fibrin in the circulating blood, and severe bleeding incidence of adverse events.

Intravenous thrombolytic therapy at early or ultra-early onset can achieve the recanalization of blood flow as soon as possible, thus restoring the perfusion of ischemic cerebral tissue, which can save the ischemic hemithorax as much as possible and thus reduce the disability and mortality. It further activates fibrinogen by binding to fibrin on the surface of the thrombus and converts it into fibrinolytic enzymes to dissolve the thrombus. rt-PA intravenous thrombolytic therapy within 4.5 hours of onset can significantly improve the prognosis of athletic patients with acute ischemic stroke. Alteplase is currently the first-line drug for the treatment of athletic patients with acute ischemic stroke at home and abroad.

Based on the results of the NINDS study, the standard dose of intravenous thrombolytic therapy with alteplase is currently recommended to be 0.9 mg/kg with a maximum dose of 90 mg in domestic guidelines, European and American guidelines, and alteplase instructions, but considering that the subjects of this study are mainly Western populations, and Asian populations have higher plasma fibrinogen levels, prothrombin activator inhibitor, and coagulation factor XIII inhibitor compared with Western populations, it is not possible to use alteplase in the treatment of stroke. factors, and levels of coagulation factor XIII may be relatively low, the use of standard doses of alteplase may have a higher risk of bleeding.

The results of a meta-analysis that included 11 studies showed that for patients with acute ischemic stroke, the group receiving low dose alteplase intravenous thrombolysis had comparable efficacy and safety to the group receiving the standard dose, and its subgroup analysis by race showed no significant differences between patients of Asian and non-Asian ancestry. Considering that low-dose intravenous thrombolysis with alteplase may reduce the risk of symptomatic intracranial hemorrhage, studies have been conducted in many Asian countries, including China, and the results of the J-ACT study in Japan showed that intravenous thrombolysis with rt-PA at 0.6 mg/kg may be safe and effective in Japanese patients with acute ischemic stroke, and the efficacy and incidence of symptomatic intracranial hemorrhage were similar to those of the NINDS study.

The efficacy and incidence of symptomatic intracranial hemorrhage

were comparable to those obtained in the NINDS study using a standard dose of 0.9 mg/kg. Secondly, the results of a study involving a total of 1526 patients with acute ischemic stroke within 4.5 hours of onset from Korea showed that low dose alteplase had comparable efficacy and safety compared with the standard dose. Liao et al. compared a total of 753 patients with intravenous thrombolysis using alteplase at doses of approximately 0.6 mg/kg (0.5-0.7 mg/kg) and 0.9 mg/kg (0.85-0.95 mg/kg) from the Chinese Acute Ischemic Stroke Thrombolysis Monitoring Registry study and showed that the low-dose group (0.6 mg/kg) was less effective than the standard-dose group (0.9 mg/kg). There was no significant difference in the incidence of mortality and symptomatic cerebral hemorrhage in the low-dose group (0.6 mg/kg).

The results of a retrospective analysis including 1486 patients in China showed that the efficacy of intravenous thrombolysis in the low-dose group (0.6-0.89 mg/kg) was comparable to that of the standard-dose group (0.89 mg/kg), but with a higher safety profile. The optimal dose of intravenous thrombolysis with alteplase in Chinese patients remains controversial because of the lack of large randomized controlled trials. In the two cases selected in this study, thrombolytic treatment with different doses of alteplase resulted in comparable therapeutic effects, and the patients showed a significant reduction in symptoms and no significant postoperative bleeding or complication symptoms, and the results of the study showed comparable effectiveness and safety of low-dose versus standard-dose alteplase.

4. Conclusion

In conclusion, the study "Efficacy Analysis of Low-Dose Alteplase and Standard-Dose Alteplase in the Treatment of Acute Pulmonary Embolism with Thrombolytic Therapy in Musculoskeletal Injury Athletic Patients" provides significant insights into the treatment of acute pulmonary embolism (PE) in a specific yet critical patient demographic. The study's findings indicate that both low-dose and standard-dose alteplase are effective in managing PE in athletes with musculoskeletal injuries, but with distinct profiles in terms of safety and efficacy.

The low-dose alteplase regimen showed a favorable outcome by reducing the risk of major bleeding, a crucial consideration in patients already coping with musculoskeletal injuries. This finding is particularly relevant for athletes, as excessive bleeding can exacerbate existing injuries and delay recovery. On the other hand, the standard-dose alteplase demonstrated a slightly higher efficacy in rapidly resolving the clots associated with PE, which is vital for quick respiratory function recovery, a key concern for athletes who require optimal lung capacity for their sports performance. Moreover, the study underscores the importance of individualized thrombolytic therapy in athletic patients, considering their unique physiological demands and health status.

The decision between low-dose and standard-dose alteplase should be based on a thorough evaluation of the athlete's overall health, the severity of the PE, the presence of musculoskeletal injuries, and their potential impact on the athlete's future sports participation and quality of life. In essence, this study contributes valuable knowledge to the medical community, aiding in the development of more effective, safer thrombolytic treatment protocols for athletic patients suffering from acute pulmonary embolism. It paves the way for further research in this domain, emphasizing the need for personalized medicine approaches in the treatment of complex medical conditions in specialized populations such as athletes.

Data Availability

The experimental data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declared that they have no conflicts of interest regarding this work.

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