

## 冠状动脉溶栓在 ST 段抬高型心肌梗死中的研究进展

周星儿<sup>1,2</sup> 赵施皓<sup>1,2</sup> 郭宇婷<sup>1,2</sup> 金荣杰<sup>1,2</sup> 王继航<sup>1,2</sup> 王建<sup>1,2</sup> 郭毅<sup>1,2</sup> 田进文<sup>1,2</sup> 沈明志<sup>1,2</sup>

(1. 南方医科大学第二临床医学院, 广东 广州 510000; 2. 解放军总医院海南医院心内科, 海南 三亚 572013)

**【摘要】** ST 段抬高型心肌梗死是常见的心血管急危重症, 致死率和致残率高。尽早实现心肌再灌注可有效挽救濒死心肌, 改善 ST 段抬高型心肌梗死患者的预后, 冠状动脉内溶栓在实现再灌注过程中发挥重要作用。现从血栓形成的机制、溶栓剂分类、冠状动脉内正向溶栓、血栓抽吸、血栓抽吸联合冠状动脉内溶栓、冠状动脉内逆向溶栓及应用前景等方面展开综述。

**【关键词】** ST 段抬高型心肌梗死; 心肌再灌注; 溶栓剂; 冠状动脉内溶栓

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## Coronary Thrombolysis in ST-Segment Elevation Myocardial Infarction

ZHOU Xing'er<sup>1,2</sup>, ZHAO Shihao<sup>1,2</sup>, GUO Yuting<sup>1,2</sup>, JIN Rongjie<sup>1,2</sup>, WANG Jihang<sup>1,2</sup>, WANG Jian<sup>1,2</sup>, GUO Yi<sup>1,2</sup>, TIAN Jinwen<sup>1,2</sup>, SHEN Mingzhi<sup>1,2</sup>

(1. *The Second School of Clinical Medicine, Southern Medical University, Guangzhou 510000, Guangdong, China*; 2. *Department of Cardiology, Hainan Hospital of PLA General Hospital, Sanya 572013, Hainan, China*)

**【Abstract】** ST-segment elevation myocardial infarction is a common emergent and critical cardiovascular disease with high mortality and disability rate. Early myocardial reperfusion can effectively save the dying myocardium and improve the prognosis of patients with ST-segment elevation myocardial infarction. Intracoronary thrombolysis plays an important role in the process of reperfusion. This article reviews the mechanisms of thrombogenesis, the classification of thrombolytic agents, intracoronary forward thrombolysis, thrombus aspiration, thrombus aspiration combined with intracoronary thrombolysis, intracoronary retrograde thrombolysis and its application prospect.

**【Key words】** ST-segment elevation myocardial infarction; Myocardial reperfusion; Thrombolytic agents; Intracoronary thrombolysis

ST 段抬高型心肌梗死 (ST-segment elevation myocardial infarction, STEMI) 多发生于冠状动脉 (冠脉) 突然闭塞, 其致死率和致残率高, 是重要的心血管杀手。快速有效地开通闭塞血管, 尽早实现心肌再灌注, 是挽救患者生命的重要措施。心脏重症监护病房的建立, 以及静脉溶栓的广泛应用, 成功挽救了许多患者的生命。随着介入时代的来临, 静脉溶栓后联合经皮冠状动脉介入治疗 (percutaneous coronary intervention, PCI) 进一步降低了 STEMI 患者的死亡率。但在实践过程中, 直接 PCI 过程中冠脉无复流/慢血流以及恶性心律失常等再灌注损伤并发症成为了临床医生的噩梦, 由此催生了选择性冠脉内溶栓治疗, 在一定程度上改善了 STEMI 患者的预后<sup>[1]</sup>。

### 1 血栓形成和溶栓

STEMI 多因冠脉不稳定斑块破裂、糜烂基础上继发血栓形成所致, 此时冠脉血管持续和完全闭塞, 最

终造成缺血部位心肌发生坏死。斑块破裂时, 冠脉内首先形成血小板聚集而成的白色血栓。因动脉具有血压高和流速快等特点, 凝血酶易被血液冲刷而导致红色血栓不易在局部形成, 随着白色血栓的增大, 局部血流减缓并在白色血栓远端形成湍流及高浓度凝血酶, 其促使纤维蛋白原转化成纤维蛋白, 纤维蛋白通过网住血细胞最终形成红色血栓。因此, 冠脉内血栓头部为白色血栓, 尾部为红色血栓<sup>[2]</sup>。溶栓的原理是: 溶栓剂可使纤维蛋白溶解酶原转变为纤维蛋白溶酶, 纤维蛋白溶酶通过降解纤维蛋白和纤维蛋白原而限制血栓增大和溶解血栓, 最终使血管再通。溶栓剂主要降解红色血栓中的纤维蛋白和纤维蛋白原, 对白色血栓的降解作用较差。

### 2 溶栓剂分类

根据溶栓剂的作用特点及上市时间先后, 将其分为四代。第一代溶栓剂包括链激酶和尿激酶, 二者均

可通过静脉用药迅速到达堵塞血管,降解血液中的纤维蛋白,有效恢复梗死部位的血流灌注。但因二者均无纤维蛋白特异性,易引起机体广泛出血。其中,链激酶具有抗原性,临床应用易发生过敏反应<sup>[3]</sup>。第二代溶栓剂主要包括阿替普酶<sup>[4]</sup>等,能选择性地溶解纤维蛋白,溶栓效果强,且不易引起全身纤维蛋白溶解系统亢进,故出血风险较第一代溶栓剂小<sup>[5]</sup>。第三代溶栓剂以尿激酶原和替奈普酶为代表,具备冠脉再通率高、对机体纤维蛋白溶解系统影响较小以及安全性更高等优点,临床疗效确切,但最佳治疗剂量仍有待进一步研究<sup>[6]</sup>。第四代溶栓剂即纤溶酶原激活物抑制物-1,通过提升血浆中组织型纤溶酶原激活物浓度来达到溶栓目的,可口服给药,但目前临床上应用较少<sup>[7]</sup>。

### 3 选择性冠脉内溶栓

随着 STEMI 介入治疗率的逐渐提高,选择性冠脉内溶栓由于溶栓剂使用剂量低、效果确切以及出血风险小,也逐渐开始应用。包括冠脉内正向溶栓、血栓抽吸联合冠脉内溶栓和冠脉内逆向溶栓等方法。

#### 3.1 冠脉内正向溶栓

冠脉内正向溶栓,是指通过指引导管缓慢和均匀地向冠脉内注入溶栓剂,从而开通罪犯血管的方法。Fu 等<sup>[8]</sup>研究发现对于高血栓负荷的 STEMI 患者,冠脉内正向溶栓治疗可减少血栓负荷,甚至完全溶解血栓,改善 TIMI 血流分级。Jayagopal 等<sup>[9]</sup>证实,通过指引导管注射低剂量替奈普酶,可使部分高血栓负荷的患者获益。但冠脉内正向溶栓因溶栓剂顺血流方向进行,易被血流冲刷;且溶栓剂局限于血栓头端的白色血栓部位,可能影响其溶栓效果。Geng 等<sup>[10]</sup>研究发现大多数通过指引导管输送的药物会在全身循环中被冲洗掉或输送到不需要的分支,只有很少的溶栓剂能到达目标冠脉病变部位。因此,为实现病变血管再通,需增加溶栓剂量,易导致出血风险增加。为减少溶栓剂用量,曾尝试应用抽吸导管送入溶栓剂,但因溶栓导管管径大,也难以直接精确地在病变部位给药,溶栓效果相对较差。此外,Maznyczka 等<sup>[11]</sup>在冠脉内注射阿替普酶对急性心肌梗死微循环影响的研究中发现,冠脉内正向溶栓未能改善微循环功能,包括微循环阻力指数、冠脉血流储备和电阻储备比等指标。这也证明冠脉内正向溶栓的效果尚不能令人满意。Alyamani 等<sup>[12]</sup>荟萃分析表明冠脉内正向溶栓降低了主要不良心血管事件,但增加了出血事件的发生率,引发了人们对于冠脉内正向溶栓安全性的担忧。因多数研究样本数较少,目前需大样本量的随机对照试验来证实 STEMI 患者冠脉内正向溶栓的安全性和有效性。

#### 3.2 血栓抽吸联合冠脉内溶栓

血栓抽吸是指应用抽吸导管机械抽吸冠脉内血栓,从而实现血管再通。Burzotta 等<sup>[13]</sup>对 100 例 STEMI 患者进行随机对照研究,发现血栓抽吸显著改善了患者的 TIMI 血流分级。陈玉善等<sup>[14]</sup>研究发现血栓抽吸对于单纯溶栓疗效较差的高血栓负荷患者,清除血栓效果更好,可迅速减少血栓负荷,从而恢复冠脉血流。但该方法存在操作难度大、微小血栓或其他微碎片损害心肌微循环最终导致心肌再灌注不良等不足<sup>[15]</sup>。同时,因为急性开通罪犯血管造成的再灌注损伤,可通过介导炎症反应造成冠脉微循环受损<sup>[16]</sup>。美国心脏病学会/美国心脏协会在 2015 年的指南中将选择性和急救性血栓抽吸的推荐级别由“II a”降为“II b”,血栓抽吸在 PCI 之前,不作为常规使用的再灌注手段<sup>[17]</sup>。因此,目前仅推荐对于血栓负荷重以及多种手段无效的患者,推荐应用血栓抽吸开通罪犯血管。为此,人们开始探索血栓抽吸联合冠脉内溶栓治疗 STEMI。Lee 等<sup>[18]</sup>通过血栓抽吸联合冠脉内溶栓使 1 例 STEMI 患者血管再通。Wang 等<sup>[19]</sup>研究证实,在血栓负荷重的 STEMI 患者中,血栓抽吸后立即冠脉内给予低剂量尿激酶原溶栓可改善心肌灌注和心功能,减少主要不良心血管事件的发生,且大出血无明显的增加。Lagerqvist 等<sup>[20]</sup>对血栓抽吸后 1 年的 7 244 例患者进行随访发现,血栓抽吸并不能显著改善患者的长期预后。Jolly 等<sup>[21]</sup>研究发现血栓抽吸与术后 30 d 患者脑卒中风险增加相关。急性心肌梗死高血栓负荷血栓抽吸推荐等级也因此被降为 II b 级,而 STEMI 患者常规血栓抽吸推荐等级则被降为 III 级。国外一项研究<sup>[22]</sup>表明在 PCI 基础上进行血栓抽吸,患者无临床获益,更不能改善长期预后。

#### 3.3 冠脉内逆向溶栓

冠脉内逆向溶栓是一种全新的再灌注方式,目的是由远及近逆血流方向缓慢溶解血栓,使闭塞血管和缺血区域心肌实现微血流、微灌注和缓开通,在有效开通闭塞血管的前提下实现再灌注预适应。冠脉内逆向溶栓的操作方法:将微导管送至冠脉血栓(闭塞部位)远端,弹丸式注射混有造影剂的溶栓剂,借助近端血栓所形成的天然屏障,保留溶栓剂于闭塞段以远,使得溶栓剂能充分接触红色血栓,从而高效和精准地溶解病变部位的血栓,可同步实现冠脉罪犯血管主干的开通以及冠脉远端小血管床内血栓溶解清除;并在此基础上进行支架植入,完成血运重建。国内田进文等<sup>[23]</sup>于 2013 年最早应用尿激酶经微导管行冠脉内逆向溶栓联合支架植入开通冠脉闭塞血管。与其他再灌注方法相比,该方法的优势在于能更彻底地清

除血栓,可视化溶栓剂使得在开通闭塞血管前能清晰地看到病变及远端血管床的真实情况,有利于精确地指导支架植入;由于逆向溶栓过程为逐渐开通血管,实现了再灌注预适应,使再灌注心律失常发生率明显降低;支架植入前显著地减少了病变部位及远端血管床的血栓负荷,使病变血管无复流/慢血流发生显著减少,从而实现心肌的有效再灌注<sup>[24]</sup>。Xiao 等<sup>[25]</sup>利用微循环阻力指数、单光子发射计算机断层成像和其他常规测量方法,评估对比了冠脉内溶栓组和血栓抽吸组患者的心肌灌注情况,证实冠脉内溶栓组的血栓负荷评分、校正的心肌梗死溶栓试验帧数、TIMI 血流分级 3 级的比例和微循环阻力指数均显著优于血栓抽吸组。郭自同等<sup>[26]</sup>发现逆向溶栓还具有溶栓剂用量小、血管开通成功率高、病变部位滞留时间长以及溶栓充分等优势。此外,史习良等<sup>[27]</sup>通过观察对比单纯 PCI 组和 PCI 联合冠脉内逆向溶栓组患者治疗前后的左心功能(包括室间隔厚度、左室后壁厚度、左室舒张末期内径、左室射血分数、左心室质量指数以及二尖瓣口舒张早期最大流速与舒张末期最大流速比率)情况,发现后者术后左心功能优于前者。

#### 4 应用前景展望

STEMI 高血栓负荷的处理仍是世界难题。既往应用血栓抽吸法达到了一定效果,并且指南推荐等级为 II a 级。国外有研究表明血栓抽吸并不能改善患者的长期预后,急性心肌梗死高血栓负荷血栓抽吸推荐等级也因此被降为 II b 级,而 STEMI 患者常规血栓抽吸推荐等级则被降为 III 级。为探索更安全和有效的再灌注疗法,田进文等<sup>[1,23]</sup>首先提出冠脉内逆向溶栓联合直接 PCI 治疗 STEMI。与冠脉内正向溶栓和血栓抽吸等传统再灌注疗法相比,冠脉内逆向溶栓具有溶栓剂用量少,溶栓部位精准,血管再通率较高,慢血流和无复流发生率较低,技术操作简单等优势。但同时也存在研究例数少,以及术式尚无统一规范标准等局限性,目前仍无大样本的临床试验展开,同时也无前瞻性和多中心的随机对照试验展开。因此,为实现更有效的心肌再灌注疗法,亟需开展冠脉内逆向溶栓大样本的试验研究。

#### 5 结语

STEMI 目前仍是全球范围内冠状动脉粥样硬化性心脏病患者的首要死亡原因,快速开通闭塞血管,恢复闭塞血管血流,以及实现再灌注,可有效地改善左心室功能,是挽救 STEMI 患者的主要治疗手段。PCI 可迅速开通堵塞血管,但因其术后无复流发生率较高(30%~40%)<sup>[28]</sup>,且该现象可导致短期不良预后事件,如恶性心律失常和心源性休克等发生率增加<sup>[29]</sup>,

故在冠脉内逆向溶栓的基础上联合 PCI 可改善血管内无复流和慢血流现象,可减少心肌梗死范围,促进左心室功能恢复<sup>[30]</sup>。随着冠状动脉粥样硬化性心脏病发病率的逐年上升,寻求更有效以及可改善患者长期预后的心肌再灌注疗法是当前的一大任务,而冠脉内逆向溶栓联合直接 PCI 为此提供了新思路。

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