北京朝阳医院
BEIJING CHAO-YANG HOSPITAL

Reperfusion Injury Prevention, A Volume-Controlled Reperfusion Method in Acute Coronary Artery Occlusion

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“Volume Controlled Revascularization ”in STEMI PPCI (VCR)

Combination of “optimized iPOST” & Gradual reperfusion

“Ping-Pong” technique, Balloon & aspiration catheter, respectively

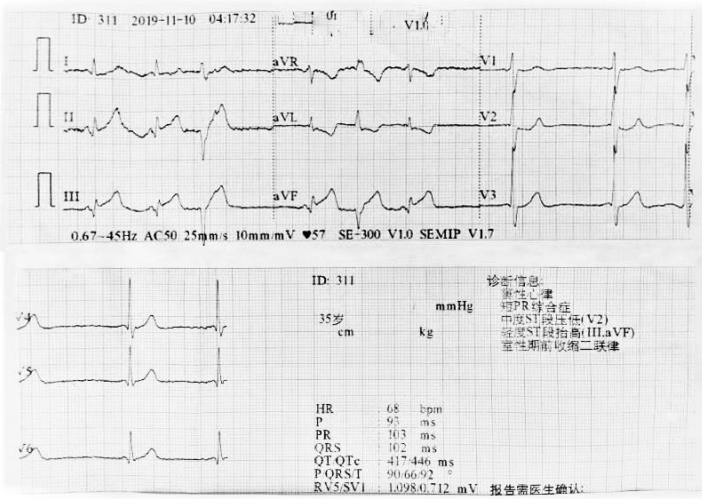
Contemporaneous forward blood flow balloon inflation blocking at the occlusion site and distal reperfusion via aspiration catheter

Stent or DCB as usual when hemodynamic data and blood flow are stable

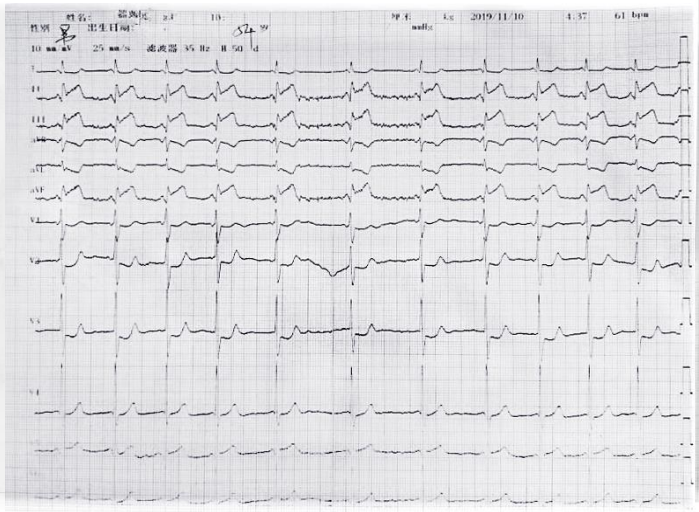
Case presentation, case 1

- 54 y/o male, chest pain 6 hours
- intravenous thrombolysis 4 hours ago (Recombinant human prourokinase , rhPro-UK, 20mg iv st, 30mg iv drop at 1mg/min)
- No history of hypertension, diabetes or smoking
- On arrival his heart rate was 80 bpm, blood pressure was 130/80 mmHg. No heart murmurs or rales in auscultation.
- TnI 0.08ng/ml（0-0.5ng/ml）

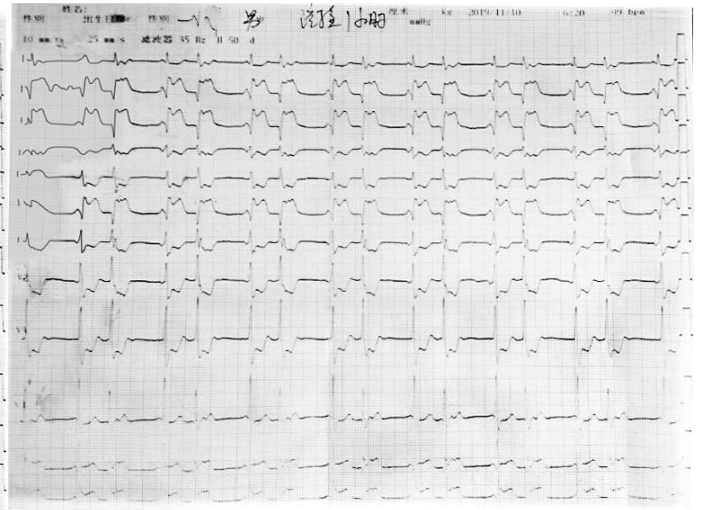
ECG Serie



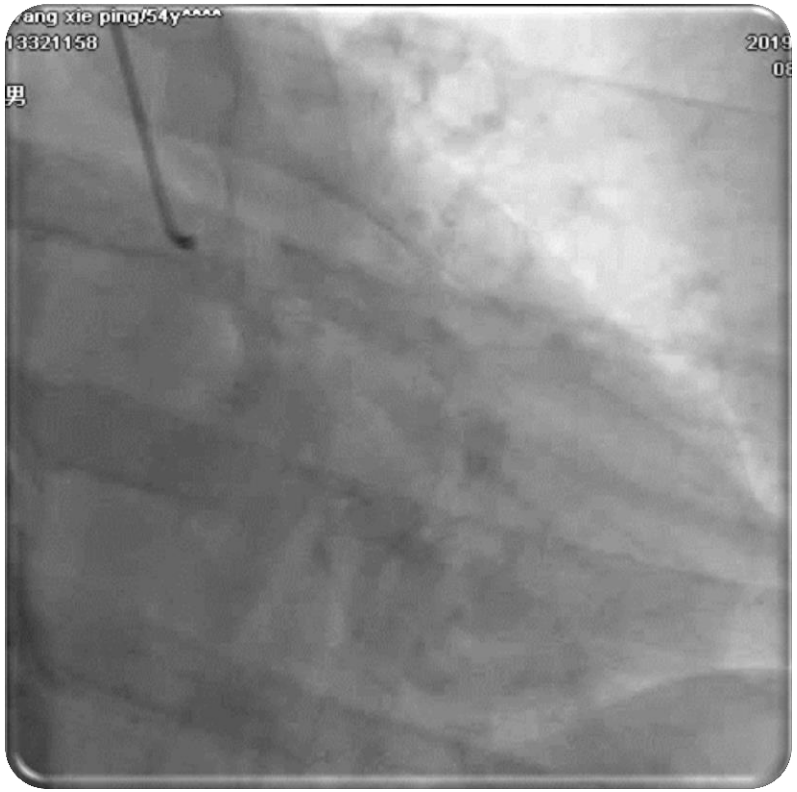
On Ambulance

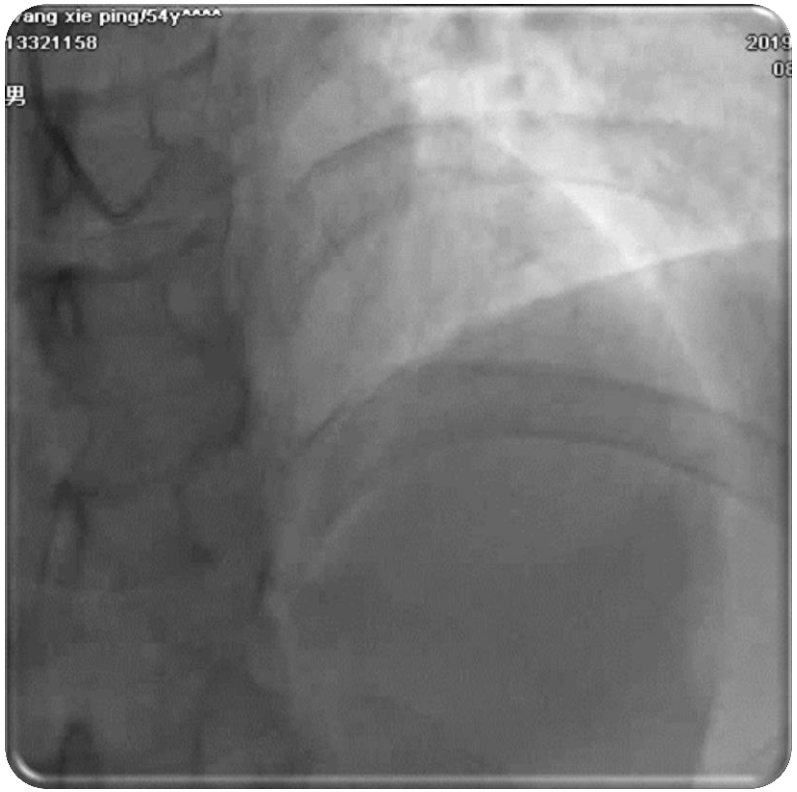


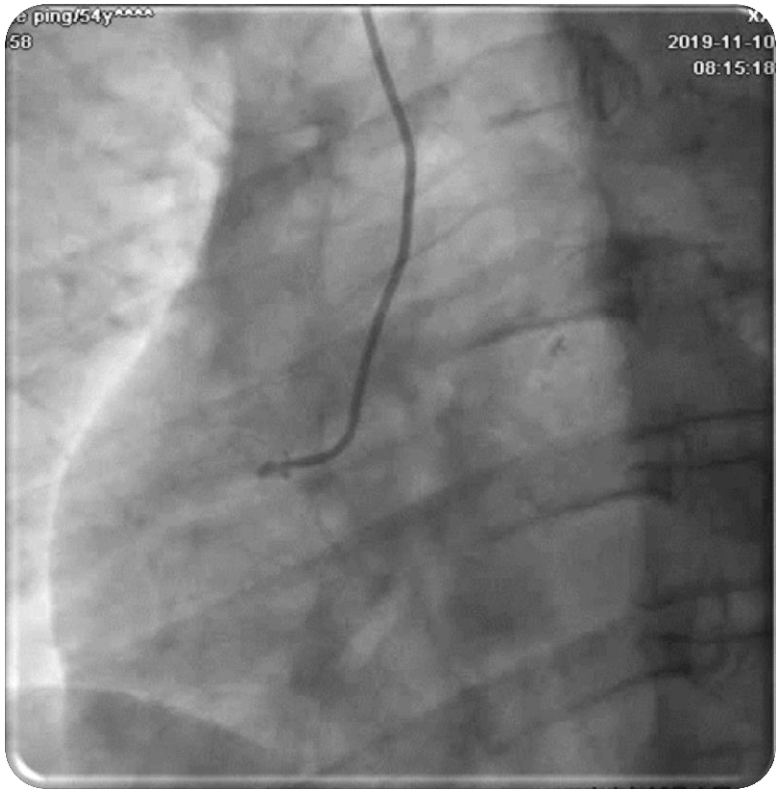
Pre-thrombolysis



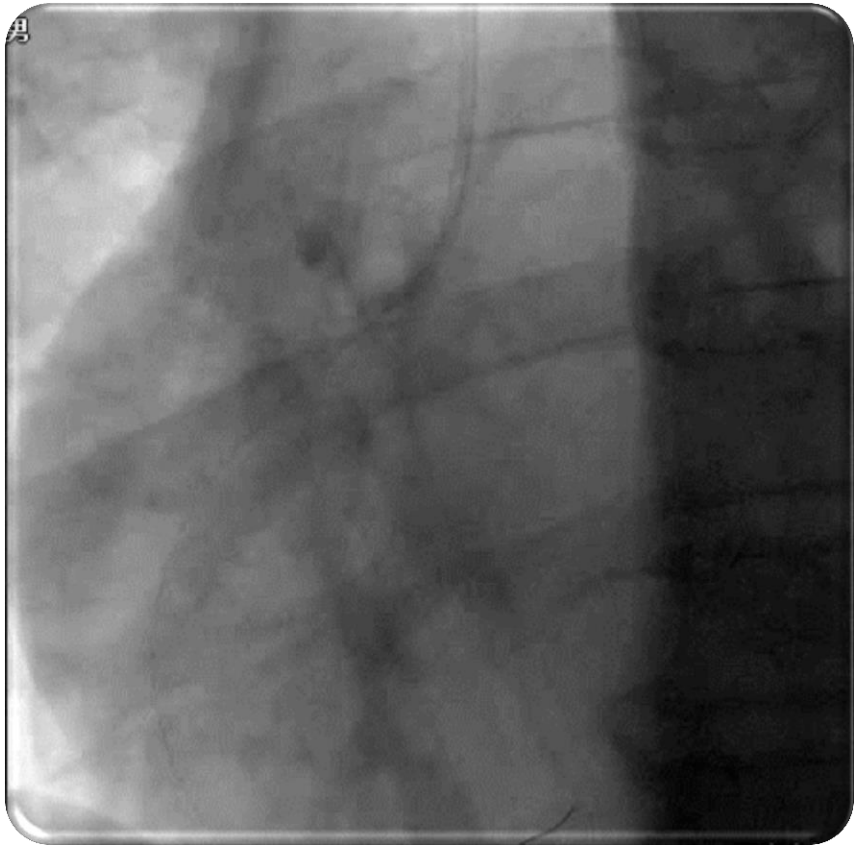
1 hour after thrombolysis





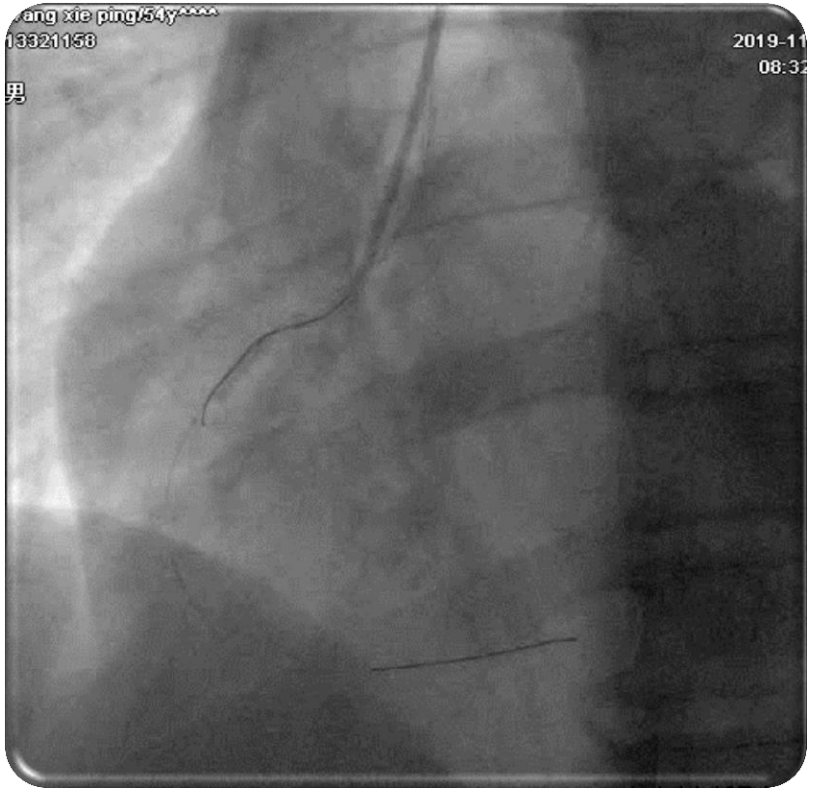


Angiography indicated total occlusion in proximal RCA, TIMI 0

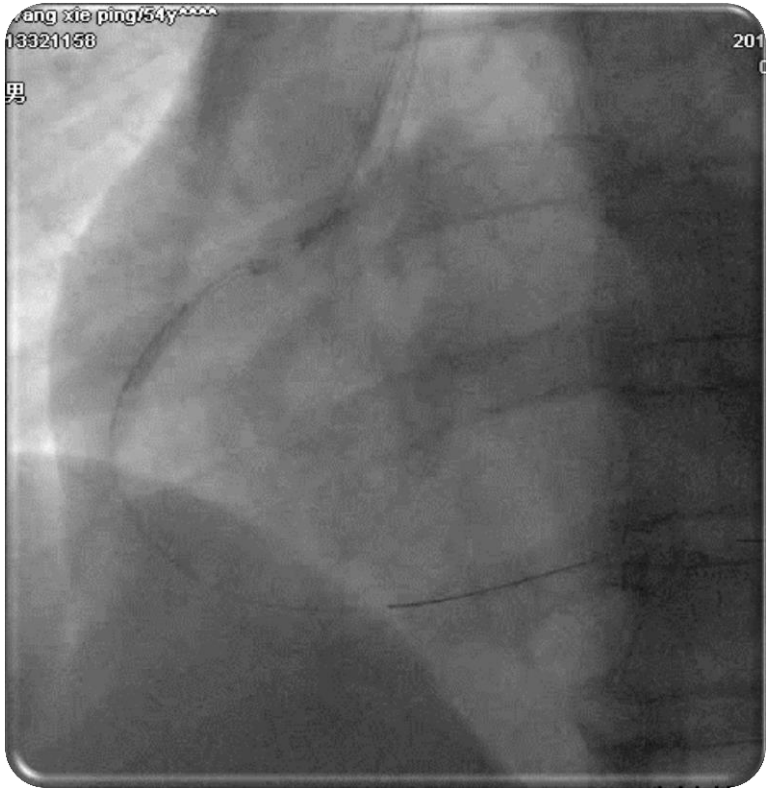


- RA route, 6FJR 4， 3.0-15mm NC balloon standby
- Heart rate drop to 40-50bpm, blood pressure drop to 70/50mmHg while BMW wire manipulation
- NC balloon inflated at proximal RCA, heat rate and blood pressure gradually back to stable

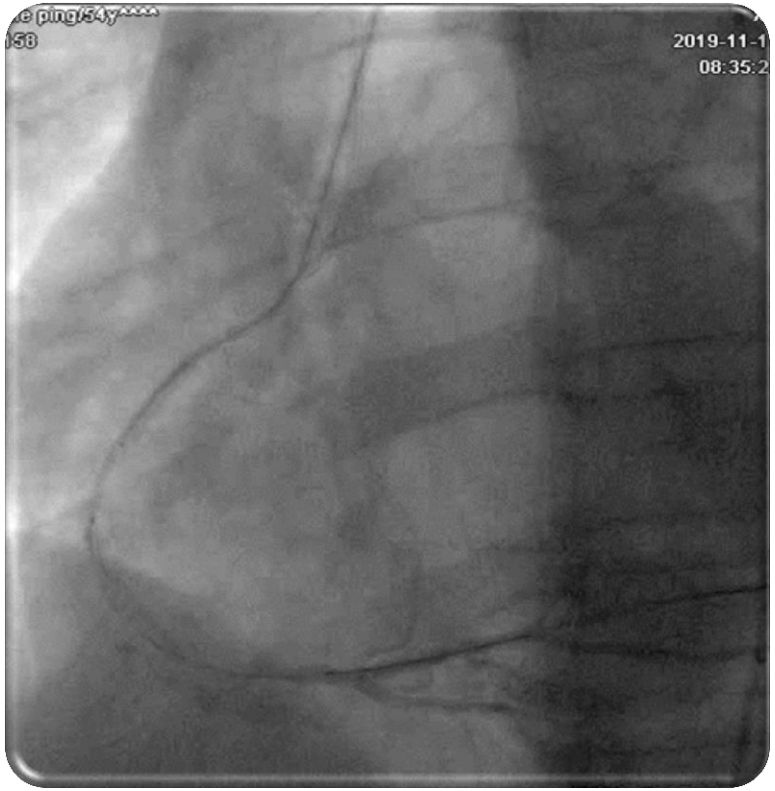
Reperfusion injury happens while workhorse wire manipulation



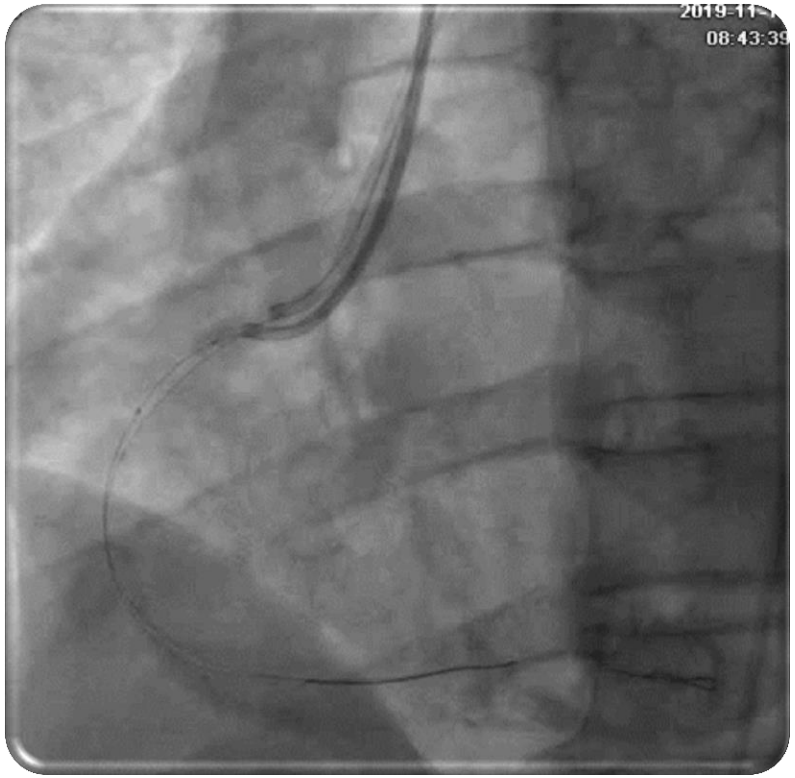
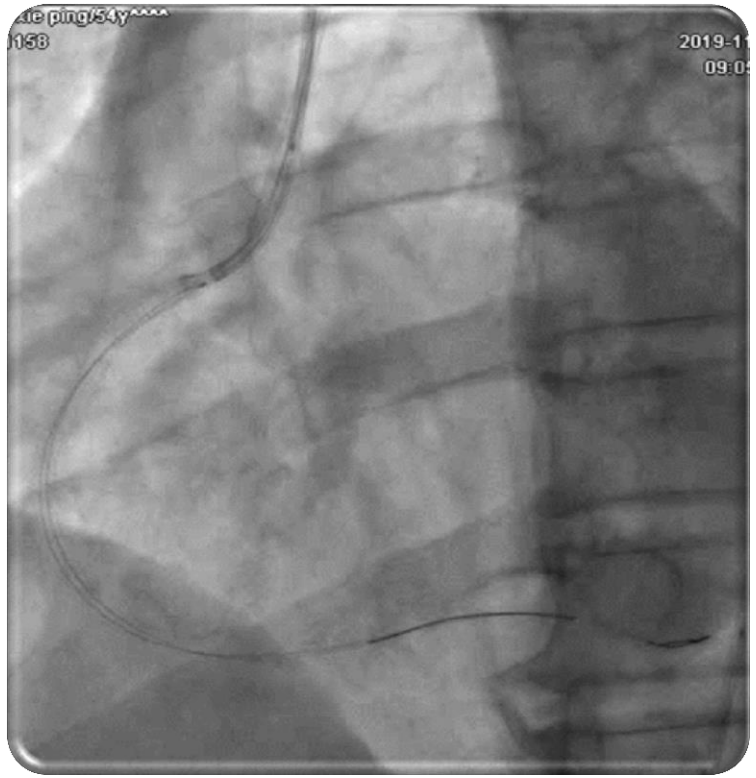
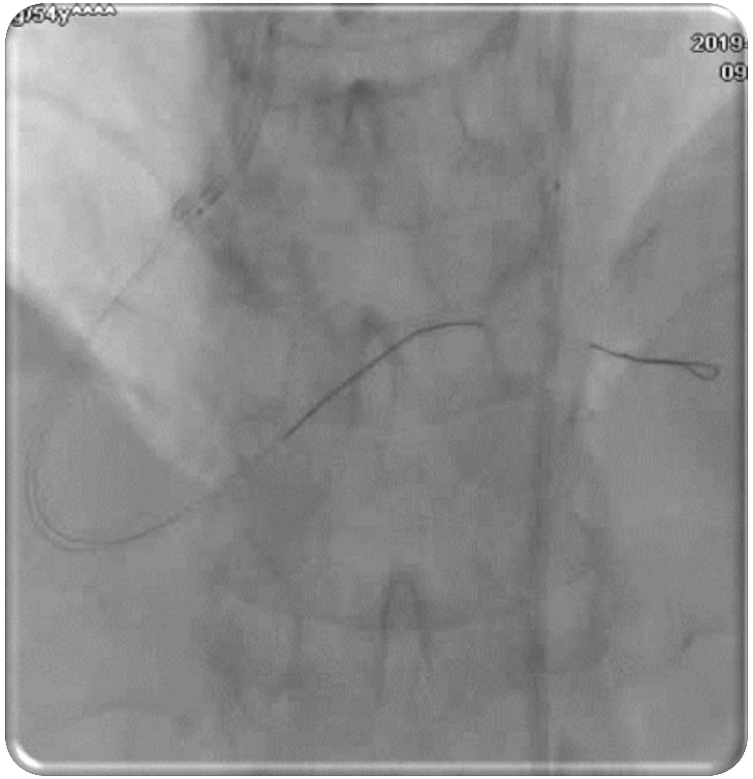
- RF route, 6FJR4，
- BMW2 to RCA distal



- Aspiration catheter was positioned 10-15mm advanced of NC balloon
- Keep 3.0NC balloon inflation at 8atm to block forward blood flow

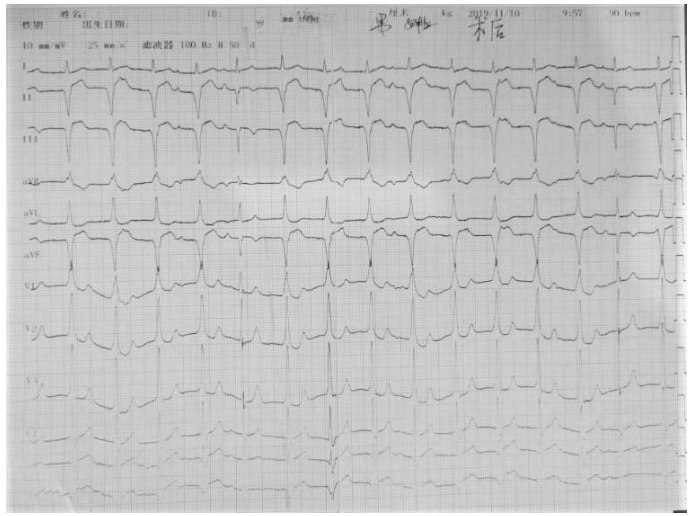


- Angiography via aspiration catheter to confirm distal part patency
- Keep 3.0NC balloon at 8atm，
- Intra-aspiration catheter infusion of mixture solution (artery blood 10ml +heparin NS 10ml)
- 20ml/min for 5 mins

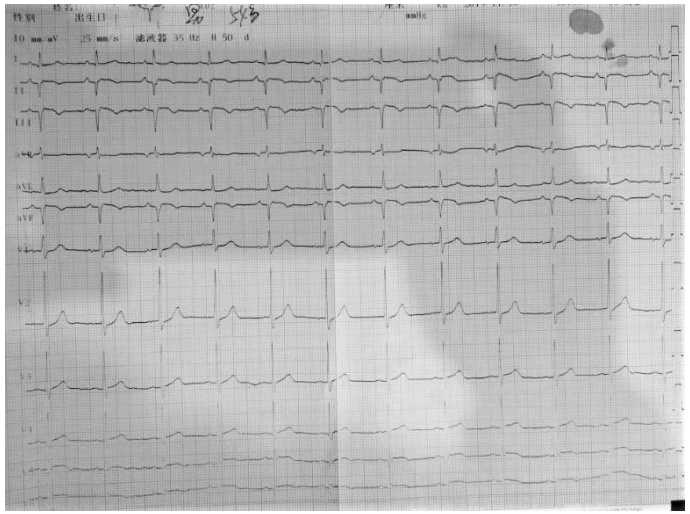




- Balloon deflated, perform angiography when hemodynamic status was stable.
- Two overlapping drug-eluting stents were deployed from mid to proximal RCA. 3.5-23mm,3.0-15mm
- 3.5-4.0NC balloon post dilation

After catheterization



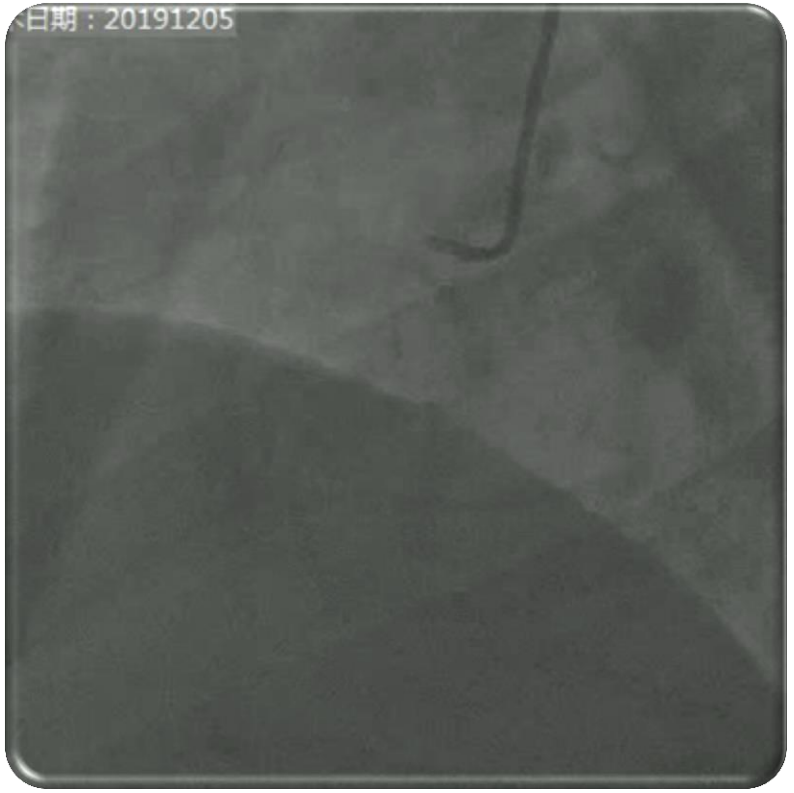
Transient arrythmia



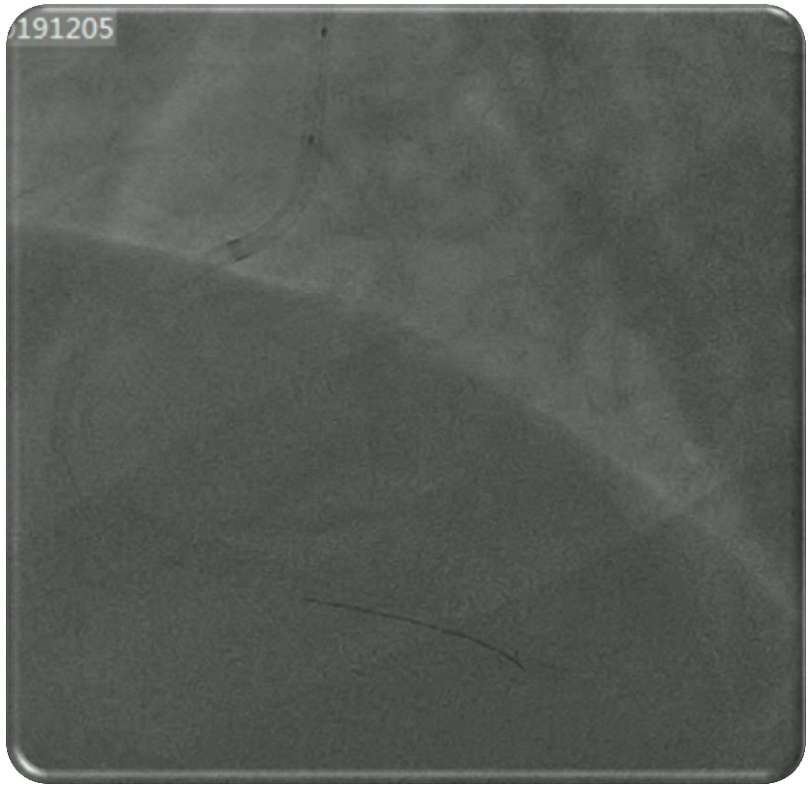
Self converting sinus rhythm

- Patient was safe transferred to ICU with blood pressure 124 /70 mmHg, heart rate 60 BPM, both lungs were free of rales.
- Elevated ST-segment resolute to base level .
- Echocardiography on day 1: Lower left ventricular posterior wall motion; LVED was 55 mm; EF58%; minor regurgitation in mitral, tricuspid and aortic valve area; a small amount of pericardial effusion. Echocardiography on day 7 maintained stable.
- BNP was 115.3 ng / ml (0-100 ng / ml) after catheterization and was 200ng/ml on discharge. Peak Troponin I level was over 50ng/ml (0-0.034) on day 1 and dropped two-fold after 24 hours.
- No arrythmia or severe discomfort was documented.

CASE 2



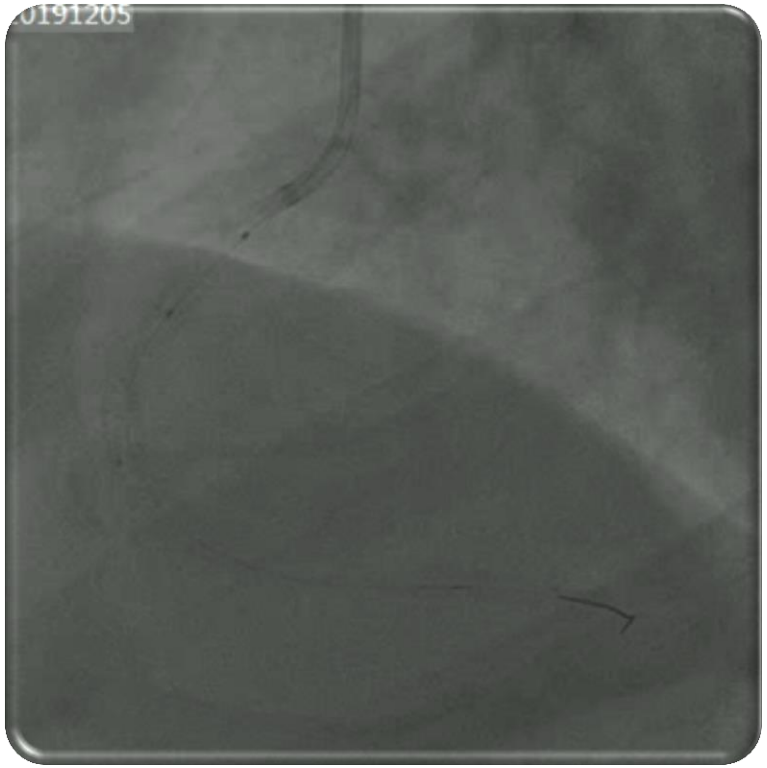
- Acute inferior STEMI,
- Total occlusion in proximal RCA, in-stent occlusion
- Balloon occlusion and micro-catheter within one 7F guiding catheter



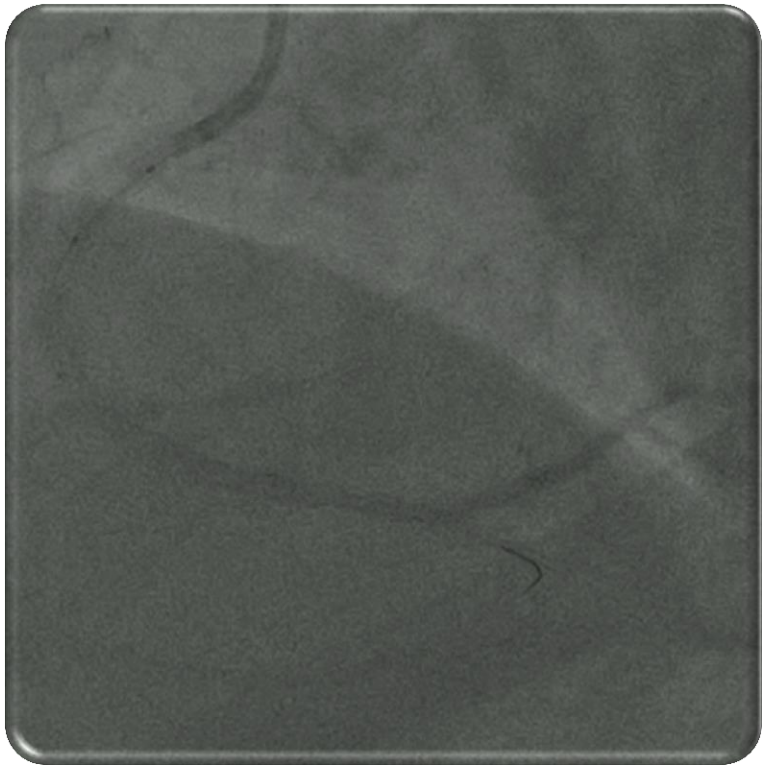
JR 4.0 GC 导丝到达RCA远端后进入3.5*16乳突球囊8atm封闭前向血流。

进入APT 130mm微导管至乳突球囊远端约20mm，冠脉闭塞病变远端前向通畅

保持前向血流封闭，经微导管注射（动脉血5ml+肝素盐水15ml）/分钟，共三次，约3-5分钟
冠脉用微导管内腔直径小，不足以维持20ml/分的流量，灌注费力



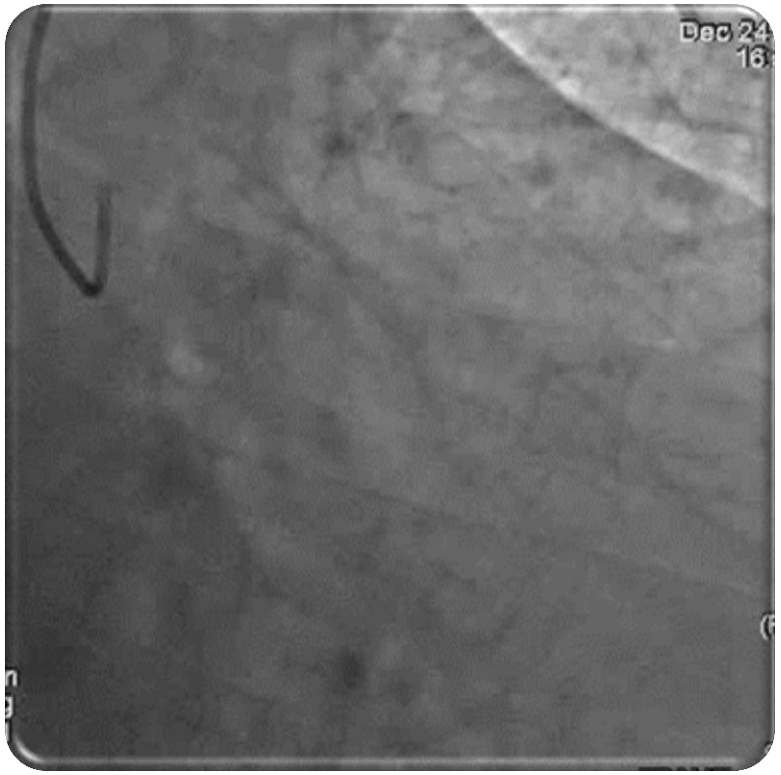
造影示球囊闭塞远端支架内狭窄，前向血流TIMI III
注意球囊扩张位置落在靶病变近端

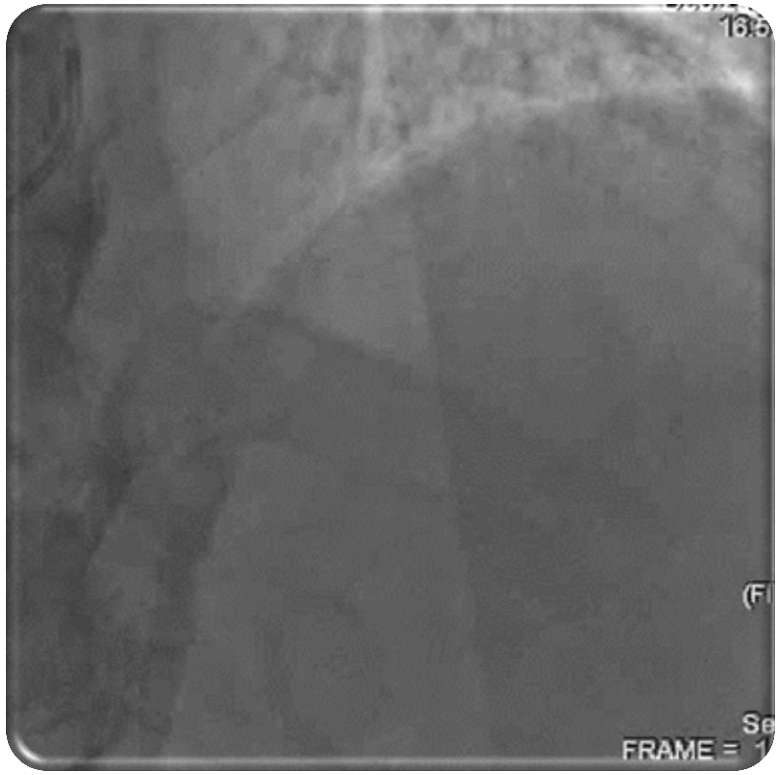


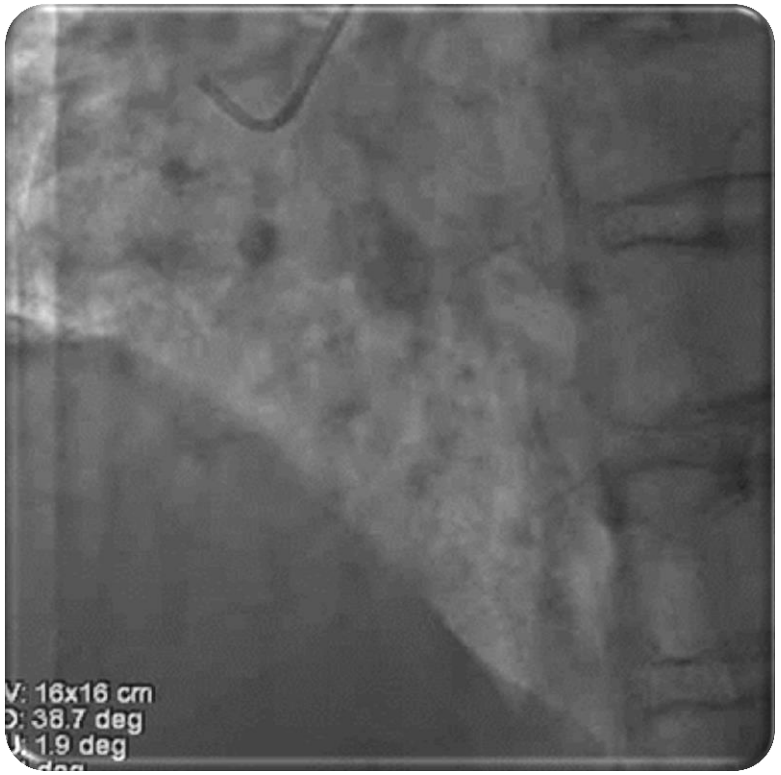
再次进入原3.5*16乳突球囊10atm扩张


造影示前向血流TIMI III

- 3.5*30mm 药物涂层球囊释放后造影示局部残余狭窄<30%， 血流通畅术中术后生命征稳定
- 本例使用单入路，球囊+微导管方式。
- 现有合规微导管推送流量不能达到20ml/min以上，
- 按照目前医保和耗材管理标准，其他微导管不能使用

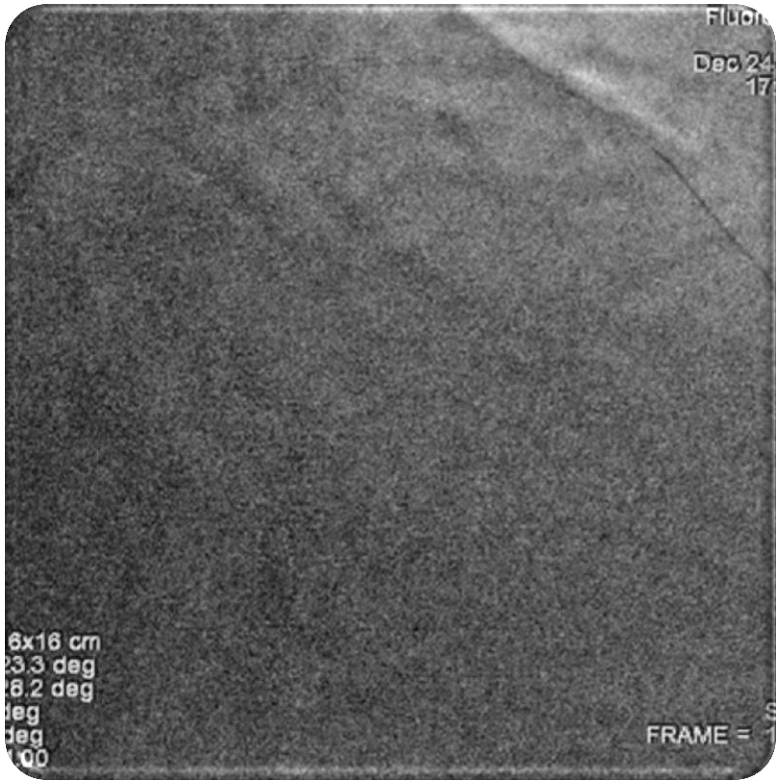


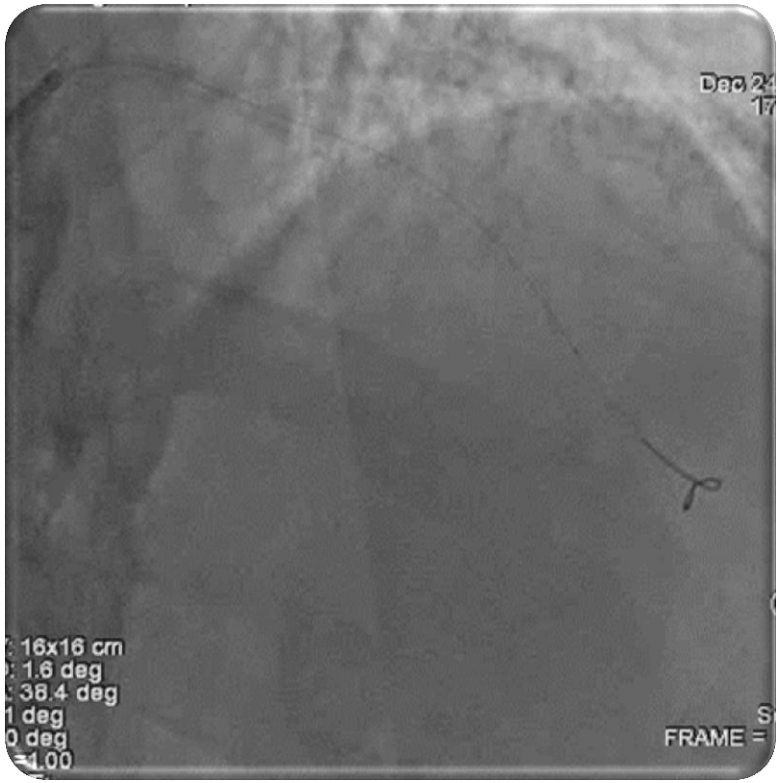


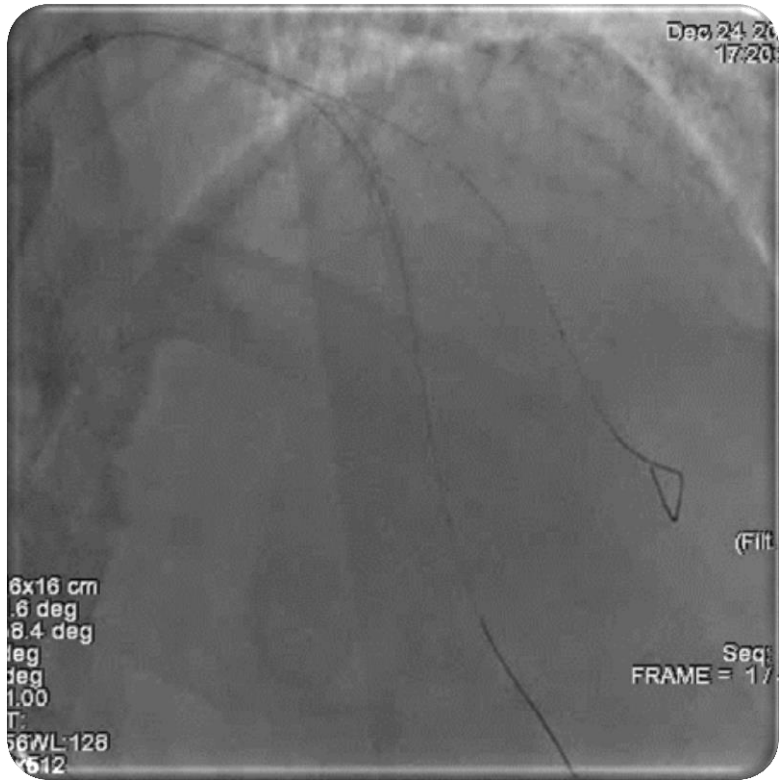


CASE 3

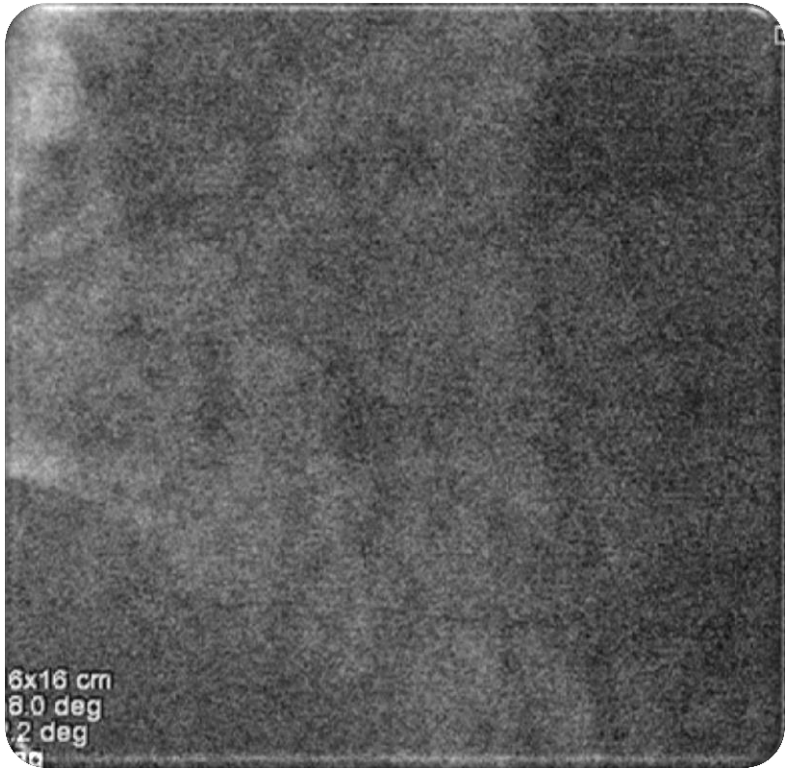
- 急性下壁正后壁心肌梗死，急性前壁ST抬高心肌梗死
- LAD近端闭塞，TIMI 0-1；RCA 近端闭塞，TIMI 0。平卧胸闷，轻度气促。血压130/80mmHg
- 桡动脉-股动脉途径，分别进入闭塞球囊和抽吸导管完成近端闭塞和闭塞段远端灌注
- 顺利完成五次冠脉内注射，前向推送顺利，即刻血流TIMI III，术中术后患者情况稳定
- 此病例为双支血管闭塞，非左主干病变，术前无心原性休克



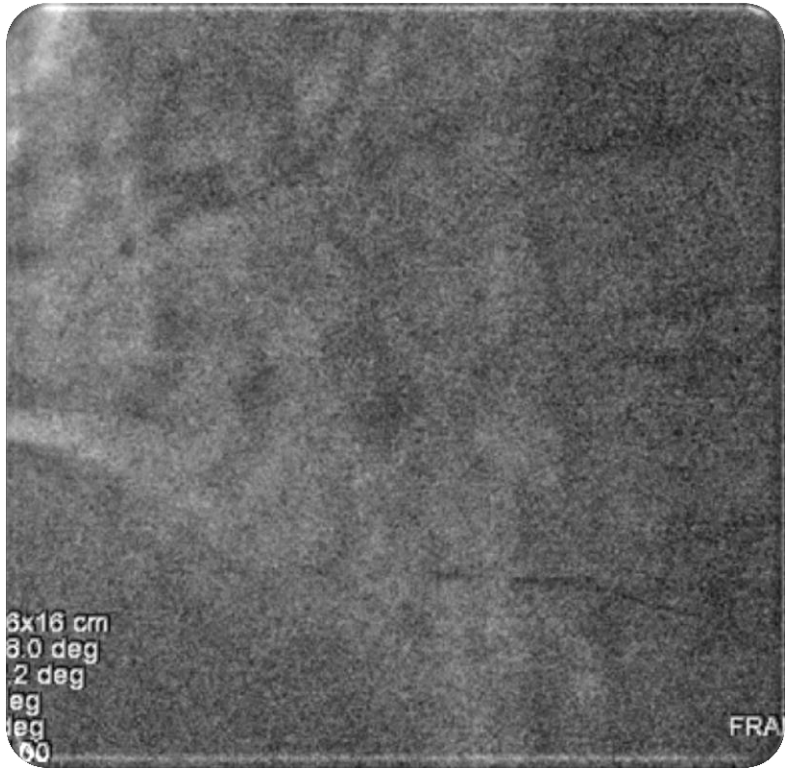




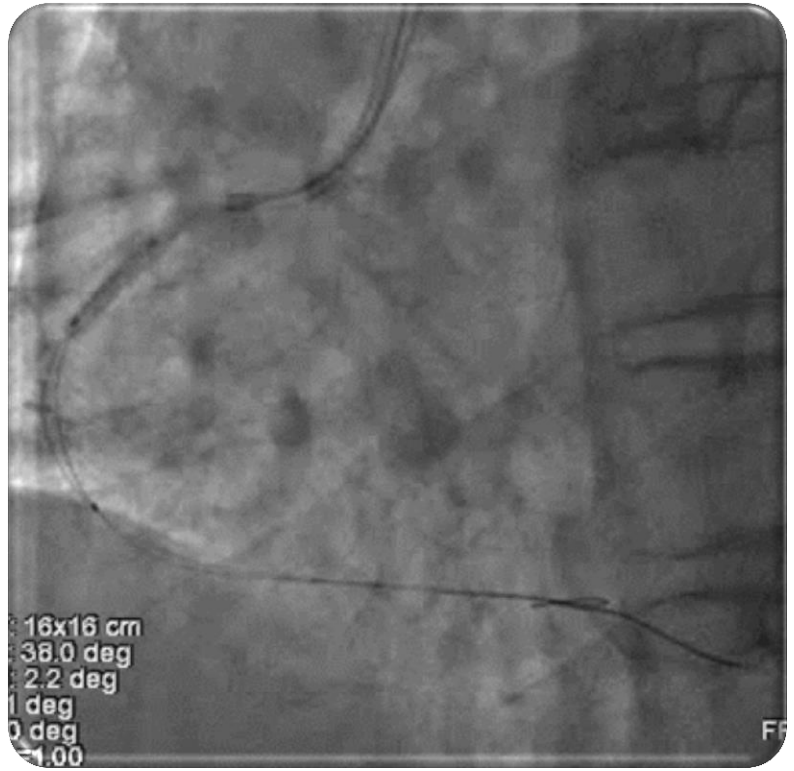
LAD近端迂曲，Fielder XT导丝通过近端闭塞病变进入对角支，更换工作导丝后
前降支近端至中段分别置入Firebird 3.0*23mm， 2.5*29mm支架
可见LAD经心尖和穿膈支提供RCA侧枝



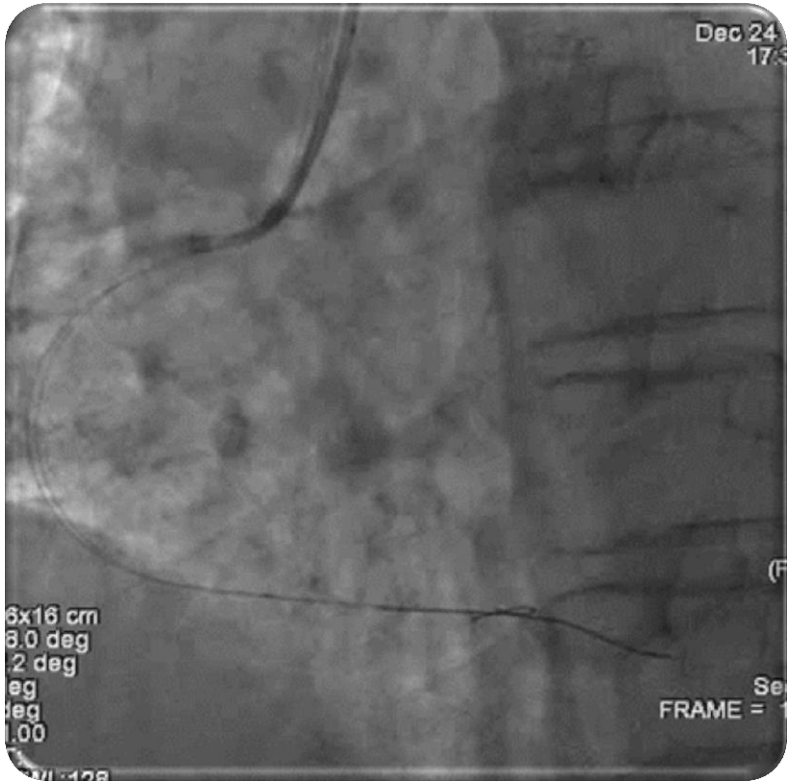
经桡动脉JR 4 GC 延导丝进入3.5 NC球囊8atm阻断前向血流



经股动脉JR 4 GC延导丝进入抽吸导管至球囊远端约20mm



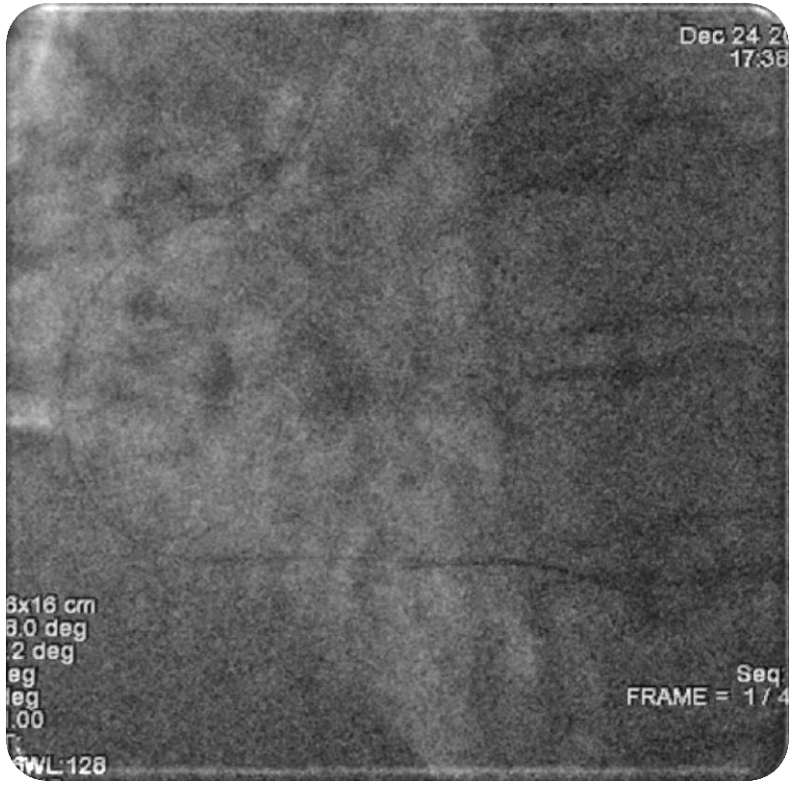
经抽吸导管造影，提示远端血管通畅



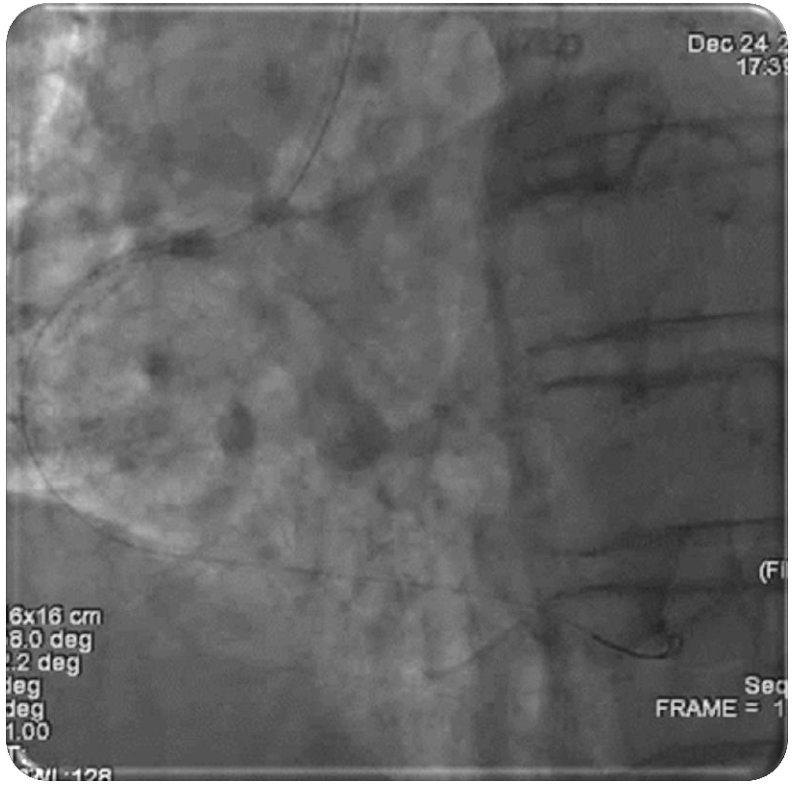
经抽吸导管注射

（动脉血10ml+肝素盐水10ml）/分钟

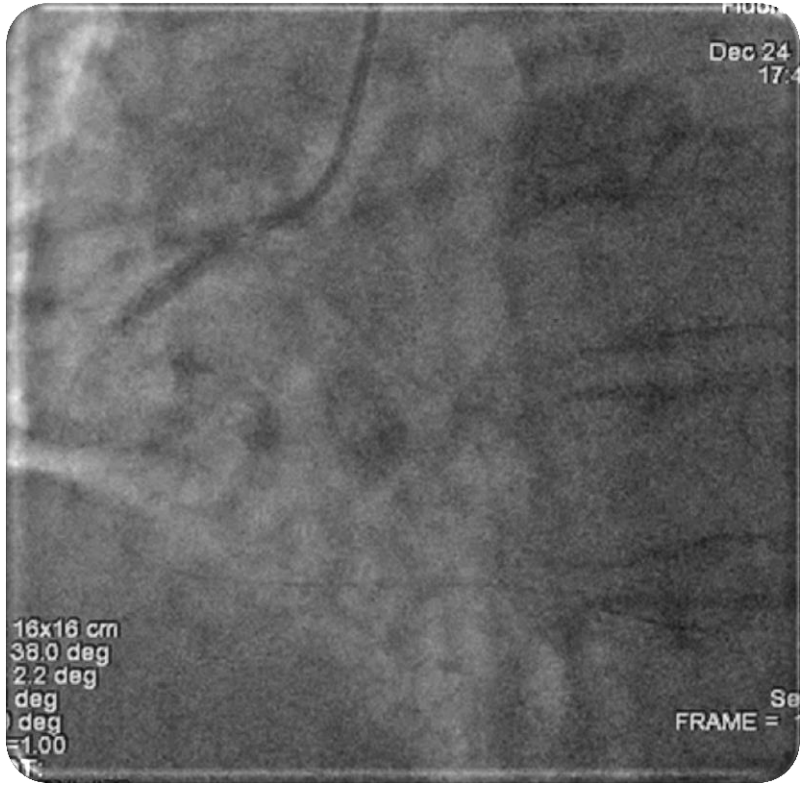
共5次，约5-7分钟，血流通畅 TIMI III

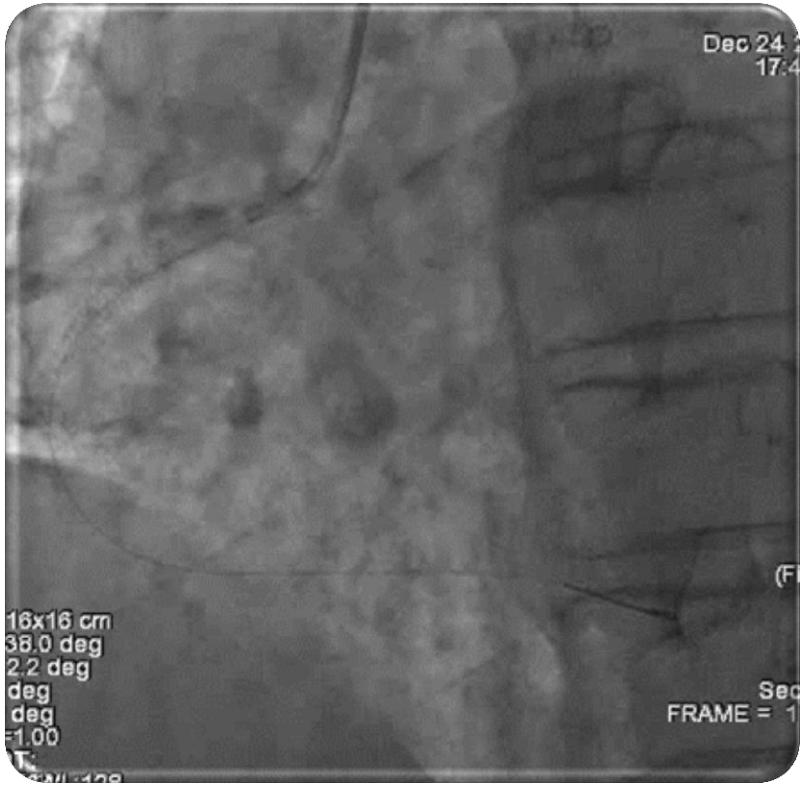


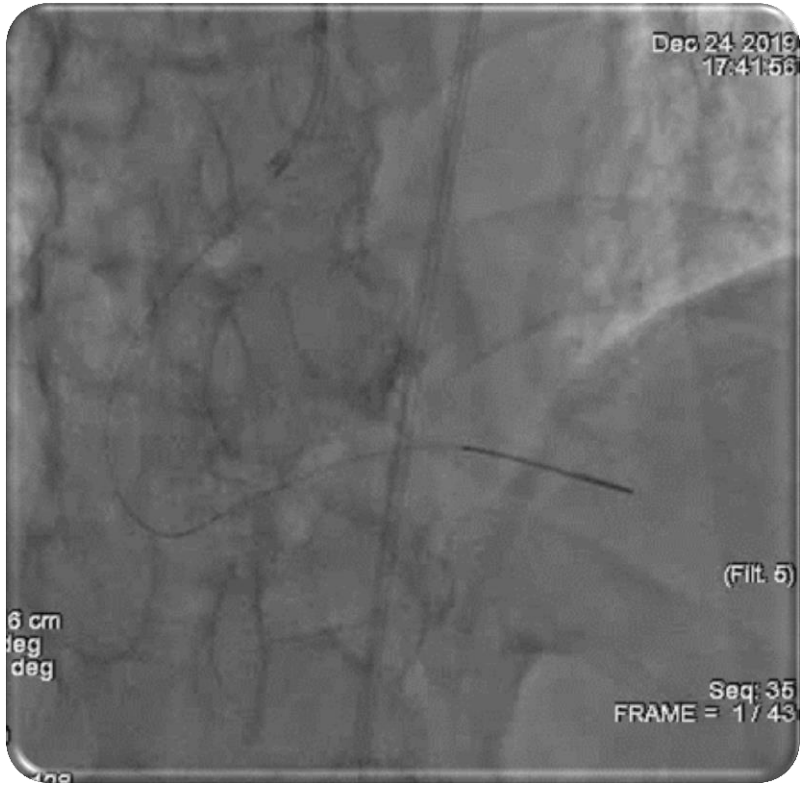
置入Firebird 4.0*29mm支架



血流通畅，原闭塞近端残余狭窄







4.0 NC球囊多次后扩张后，无残余狭窄，血流TIMI III
心率血压稳定，血压105/80mmHg

讨论：

1

经典后适应操作仍然在不断改进中：启动时间，流量管理，循环次数和操作时长，启动和终止标准

2

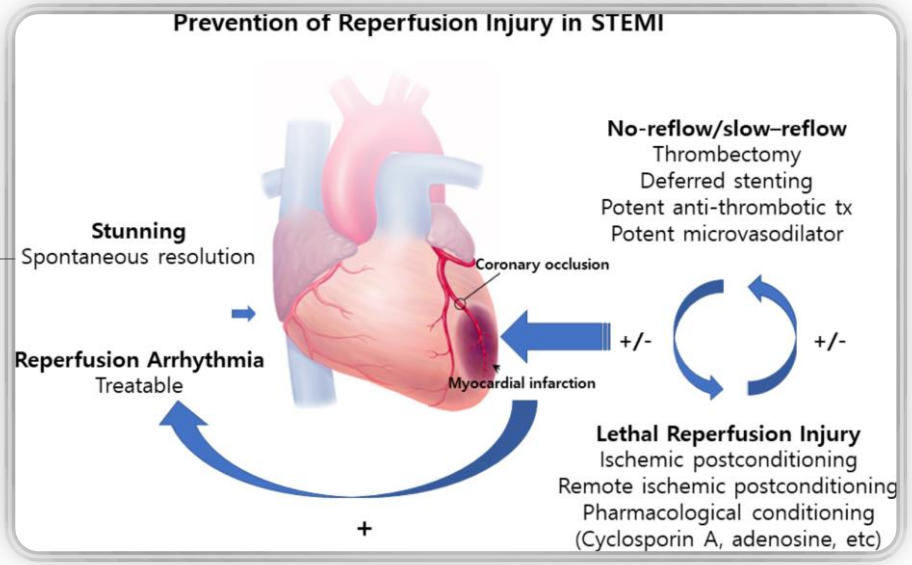
缺血再灌注保护靶点转变？从保持AAR心肌细胞线粒体完整性和控制mPTP开放，到非心肌细胞，例如血管内皮细胞再灌注损伤保护。

3

保护性操作终止标准，是定时定循环次数操作还是根据血流或心率血压稳定？

JH. Traverse, CM. Swingen, TD Henry et al. NHLBI-Sponsored randomized trial of postconditioning during primary percutaneous coronary intervention for ST-elevation myocardial infarction. Circ Res. 2019;124:769-778

再灌注损伤保护研究现状：



- 药物和缺血适应操作在动物实验和临床概念验证实验中能减轻缺血再灌注损伤
- 后适应和逐渐适应在大型临床随机实验中没有显示出一致的心功能保护作用，例如POST，DANAMI-3 IPOST。
- 再灌注损伤作用于闭塞段截面下所有缺血区域，包括损伤区域心肌细胞、冠脉循环的内皮细胞。目前认为冠脉内皮细胞虽然耐受缺血程度较高，但是对于再灌注损伤更为敏感，以微血管损伤导致的无复流可能是再灌注损伤保护的重点环节。

- Derek J. Hausenloy et al, Ischaemic conditioning and targeting reperfusion injury: A 30 years voyage of discovery Basic Res Cardiol, (2016) 111:70
- Gerd Heusch and Bernard J. Gersh, The pathophysiology of acute myocardial infarction and strategies of protection beyond reperfusion: a continual challenge. European Heart Journal (2017) 38, 774–78

1

病变部位：急诊介入治疗步骤已经日臻完善，不考虑病变部位的后适应操作可能难以观察到心功能保护作用。

2

启动时间：2008年以后广泛使用的血栓抽吸治疗延误了再灌注开始到启动后适应时间

3

操作方法：球囊扩张/减压方法交替阻断血流，球囊撤压期间仍有前向灌注血流，可能引起再灌注损伤信号刺激。同时只能控制扩张/减压时间，不能控制流量。

4

阻断部位：目前“主动后适应”方法，由于术者倾向避免/减少造影，预扩张球囊直径不足等原因。导致扩张部位可能在靶病变近端，或者操作期间不能完全阻断前向血流。

5

罪犯血管：后适应操作只能假设靶病变为局限/节段病变，不能了解远端血管通畅情况。

传统后适应操作存在的问题

我们的思路

临床体会：

缺血后适应操作可能存在上述缺陷影响对再灌注损伤的保护作用

文献回顾：

临床研究终点目标过于关注心肌梗死面积变化，忽略了对梗死相关血管、血管内皮功能、微血管栓塞的作用。

提出假设：

冠脉内皮系统再灌注损伤是心肌梗死急诊介入治疗再灌注损伤保护的重点环节。

建立新方法：

在“优化后适应”和“逐渐适应”的基础上设计出“容量控制血运重建方法”

- Gerd Heusch. Coronary microvasucular obstruction:the new frontier in cardioprotection. Basic Research in Cardiology. (2019)114:45

减轻缺血再灌注损伤，改善灌注治疗效果

建立以充分恢复冠脉血流减少微血管栓塞为一级终点的再灌注损伤保护策略

新方法研究目标

北京朝阳医院
BEIJING CHAO-YANG HOSPITAL

THANKS

谢谢您的关注