

氟碳乳剂稀释血液对心肌缺血时左心室舒张功能的影响

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提要 本实验在40只麻醉开胸兔心脏上观察了阻断冠脉血流后左心室舒张功能的变化和氟碳乳剂稀释血液对心肌缺血时左心室 $-dp/dt_{max}$, $-V_{CB}$ 和T值变化的影响。实验结果表明, 阻断冠脉血流后, $-dp/dt_{max}$ 和 $-V_{CB}$ 均明显降低, T值显著延长。阻断冠脉血流前或阻断冠脉后15min时用氟碳乳剂行等容血液稀释, 可使心肌缺血时左心室舒张功能损害明显减轻。

关键词 心肌缺血; 氟碳乳剂; 心脏功能

急性心肌缺血时, 血液流变学的异常变化是增加心脏负担、减少冠脉侧支血流量因而加重心肌缺血的重要因素⁽¹⁾。现已证明, 用具有携氧功能的人造血液—氟碳乳剂稀释血液以降低全血粘度, 可明显提高缺血区心肌的氧分压, 减轻心肌损伤, 缩小心肌梗塞范围^(2,3)。但关于它对心肌缺血时心功能的影响, 尚少报道。为了阐明氟碳乳剂对在体工作心脏急性心肌缺血时心功能的影响, 本实验观察了氟碳乳剂稀释血液对心肌缺血时左心室舒张功能的影响。

方 法

家兔40只, 体重2.2~2.4kg, 性别不拘。戊巴比妥钠静脉麻醉(30mg/kg)后, 气管插管行纯氧正压人工呼吸。于胸骨左缘切断1~5肋软骨, 暴露心脏。在冠脉左室支起点远端0.8~1cm处下方穿过一条无创缝合线以备结扎冠脉。将内径2mm的薄壁塑料管经右颈总动脉插入主动脉, 用以测量主动脉压和动脉取血。在心尖部少血管区插入导管, 用Statham P 50压力换能器测量室内压。于阻断冠脉血流前(对照)、阻断后15, 30, 45, 60min时用RM-85多导仪记录左室压、左室内压最大下降速率($-dp/dt_{max}$)和 $-dp/dt_{max}$ 时左室肌收缩成分延长速度($-V_{CB}$)。将左室压和 dp/dt_{max} 两导信号输入APPLE-II计算机, 计算 $-dp/dt_{max}$ 后左室等容舒张期压力下降的时间常数(T), 以 $-dp/dt_{max}$, $-V_{CB}$ 和T值作为左心室舒张功能的指标^(4,5)。同时监察心率(HR)、主动脉平均压(mAP)和动脉血氧分压(PaO_2 , AVL-939血气分析仪)。

动物均分为五组。I组: 对照组, 阻断冠脉血流后60min内不给实验性处理; II组: 阻断冠脉血流15min时记录各项参数后, 经股静脉输入低分子右旋糖酐(Dextran-40, 秦皇岛制药厂, 批号850619)15ml/kg, 同时经股动脉等速等量放血, 观察血液稀释后心脏舒张功能的变化; III组: 阻断冠脉血流15min后用20%全氟三丙胺(PFTA)(中国科学院上海有机化学研究所提供, 批号850823)稀释血液(15ml/kg), 观察氟碳乳剂稀释血液对心脏舒张功能的影响; IV、V组于阻断冠脉血流前分别用Dextran-40和PFTA稀释血液,

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以血液稀释后各项参数为对照, 观察心肌缺血时心脏舒张功能的变化。

结 果

一. HR, mAP 和 PaO₂ 的变化

阻断冠脉血流后, HR 与 mAP 轻度降低, 各组间变化程度无明显差异。本实验全部动物均用纯氧人工呼吸, I, II, III 组血液稀释前 PaO₂ 分别为 27 ± 1.9 kPa (203 ± 14 mmHg), 27 ± 2.8 kPa (205 ± 21 mmHg) 和 31 ± 5 kPa (231 ± 38 mmHg), 右旋糖酐稀释后 PaO₂ 未发生明显变化, 而 PFTA 稀释后 PaO₂ 显著升高达 42 ± 7 kPa (316 ± 49 mmHg) 血液稀释的四组动物血细胞比容降低 6~8%。

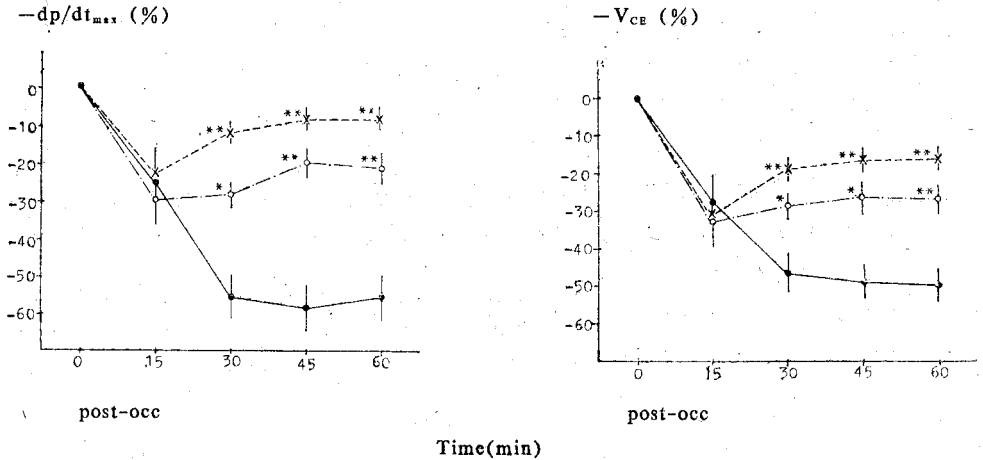


Fig 1. Comparison of the changes in $-dp/dt_{max}$ (left) and $-V_{CE}$ (right) following coronary occlusion between control group (closed circle) and hemodilution with dextran-40 (open circle) or with fluorocarbon emulsion (cross) at 15-min post-occlusion

二. $-dp/dt_{max}$ 和 $-V_{CE}$ 的变化

阻断冠脉血流前, 各组动物的 $-dp/dt_{max}$ 和 $-V_{CE}$ 值均无明显差异。缺血 15 min 时, I, II, III 组 $-dp/dt_{max}$ 和 $-V_{CE}$ 发生同等程度的降低, $-dp/dt_{max}$ 分别较对照降低 25 ± 7%, 30 ± 5% 和 24 ± 4%, $-V_{CE}$ 分别降低 29 ± 7%, 33 ± 8% 和 29 ± 6%, 而缺血 30 min 后, 血液稀释组与对照组 $-dp/dt_{max}$ 和 $-V_{CE}$ 的变化完全不同。对照组 $-dp/dt_{max}$ 和 $-V_{CE}$ 进一步降低, 缺血 45 min 时分别较对照降低 58 ± 11% 和 49 ± 7%。PFTA 稀释组 $-dp/dt_{max}$ 和 $-V_{CE}$ 的变化明显减轻, 缺血 45 min 时仅较对照降低 8 ± 2.7% 和 16 ± 5%。Dextran-40 稀释组此两项参数的变化也有一定程度的改善, 但其恢复程度弱于 PFTA 稀释组 (图 1)。为了排除心肌缺血期间行血液稀释引起的前、后负荷变化对实验结果的影响, 本实验 IV、V 组在阻断冠脉血流前先行血液稀释并以稀释后测得的各项数值为对照, 观察心肌缺血时 $-dp/dt_{max}$ 和 $-V_{CE}$ 变化的百分比。结果表明, 用 PFTA 先行血液稀释, 也可使阻断冠脉血流后 $-dp/dt_{max}$ 和 $-V_{CE}$ 的变化明显减轻 (图 2)。

三. T 值的变化

据 Weiss 等报道⁽⁴⁾, $-dp/dt_{max}$ 后左室压力呈指数下降, 压力信号经对数变换后压力一时间关系曲线为一直线, 此直线的斜率 (T 值) 不受左室前、后负荷的影响, 是反映心室肌主动舒张能力的较好指标。本实验结果表明, 阻断冠脉血流后 T 值明显增大, 缺血 30 min 时对照组 T 值延长达最大值 (63 ± 14 ms), Dextran-40 稀释组 T 值延长程度轻于对照组, 而 PFTA

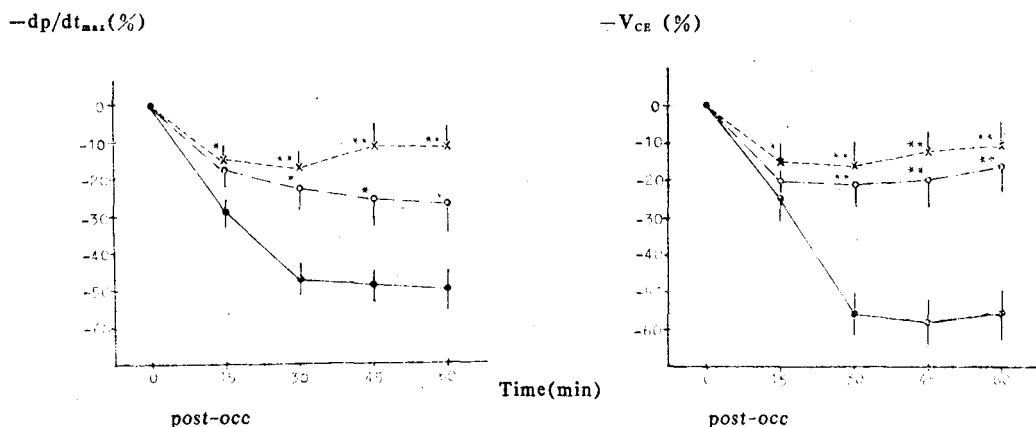


Fig 2. Comparison of the changes in $-dp/dt_{max}$ (left) and $-V_{CR}$ (right) following coronary occlusion between control group (closed circle) and hemodilution with dextran-40 (open circle) or with fluorocarbon emulsion (cross) before coronary occlusion.

Tab 1. The changes in T (ms) following coronary occlusion

Post-occ (min)	Contrpl group	Hemodilution 15 min after coronary occlusion		Hemodilution before coronary occlusion	
		FCE	Dextran-40	FCE	Dextran-40
0	29 ± 5	27 ± 7	26 ± 7	26 ± 4	21 ± 6*
15	52 ± 10	45 ± 10	38 ± 5*	39 ± 4*	28 ± 7*
30	63 ± 14	40 ± 9*	32 ± 7**	42 ± 10**	29 ± 5**
45	53 ± 10	36 ± 11**	30 ± 5**	39 ± 15**	30 ± 6**
60	53 ± 8	37 ± 11**	30 ± 3**	38 ± 14**	27 ± 5**

Note: Values are compared with control group, *P < 0.05, **P < 0.01. FCE: fluorocarbon emulsion.

稀释组延长程度最轻 (表 1)。

讨 论

近年来的研究表明, 心室舒张功能损伤是急性心肌缺血时发生较早、程度也较严重的病理生理变化。当心脏舒张顺应性降低时, 心室充盈度明显下降, 可进一步通过 Starling 效应导致心脏射血功能降低⁽⁶⁻⁸⁾。因此, 设法改善心肌缺血时心脏舒张功能, 对提高心脏的射血能力有重要意义。1985年, Mushlin 等⁽⁹⁾在离体兔心实验中首次发现, 用氟碳乳剂全部替换血液灌流心脏, 可明显改善心肌缺血时左心射血功能。本实验结果进一步表明, 用氟碳乳剂部分替换血液行血液稀释, 也可使在体心脏心肌缺血时左心舒张功能明显改善。

氟碳乳剂是 70 年代末期研制成功的一种新型代血液, 它具有氧溶解度高 (约为水的 20 倍)、氧释放效能高和颗粒微小等优点⁽⁹⁾。在急性心肌缺血早期, 全血粘度明显升高, 红细胞变形能力显著降低, 此时僵硬的红细胞很难通过因缺血水肿而狭窄了的毛细血管, 致使心肌严重缺氧。而用氟碳乳剂稀释血液后, 则由于“血浆”中溶解氧明显增加, 侧支循环供氧量增多, 因而改善心脏功能。值得指出的是, 本实验中用低分子右旋糖酐稀释血液对心脏舒张功能的改善作用虽弱于氟碳乳剂, 但确可使心功能损伤程度发生一定程度的减轻。这一结果提示, 急性心肌缺血时缺血区内酸性代谢产物蓄积, 是导致心功能损伤的重要因素之一, 右旋糖酐稀释血液虽不能增加缺血区心肌的供氧量, 但可使侧支血浆流量明显增加, 因而冲洗代谢产物, 减轻心肌缺血。

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THE EFFECT OF HEMODILUTION WITH FLUOROCARBON EMULSION ON THE CHANGES IN LEFT VENTRICULAR DIASTOLIC FUNCTION FOLLOWING CORONARY OCCLUSION

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ABSTRACT Changes in the left ventricular diastolic function following coronary occlusion and the effects of hemodilution with fluorocarbon emulsion on the alterations of $-dp/dt_{max}$, $-V_{CE}$ and the time constant of isovolumic pressure fall subsequent to $-dp/dt_{max}(T)$ during myocardial ischemia were observed in 40 anesthetized open-chest rabbits. The animals were randomly divided into five groups, animals in group 1 were untreated during myocardial ischemia (control group) and that in group 2 and 3 were hemodiluted with dextran-40 or fluorocarbon emulsion, respectively, at 15 min post-occlusion. Animals of the other two groups, hemodilution with dextran-40 (group 4) or fluorocarbon emulsion (group 5) were performed before coronary occlusion. It was shown that, after coronary occlusion, both $-dp/dt_{max}$ and $-V_{CE}$ were decreased significantly and T was prolonged obviously. At 15 min post-occlusion, $-dp/dt_{max}$, $-V_{CE}$ and T changed to the same extent in group 1, 2 and 3. However, Their alterations were quite different in the three groups after 30 min of coronary occlusion. In group 1, cardiac function was further aggravated; in group 2, it was not worsened and in group 3, it was improved distinctly. Pre-occlusion hemodilution with fluorocarbon emulsion could also improve cardiac function following coronary occlusion. These results suggest that hemodilution with fluorocarbon emulsion has a beneficial effect on left ventricular diastolic function during myocardial ischemia.

Key words Myocardial ischemia; Fluorocarbon emulsion; Heart function

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