DOI:10.16016/j.1000-5404.1994.04.002

An investigation of the incidence of micronucleated erythrocytes after multiple inhalations of butadiene with flow cytometry in mice

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Abstract The incidence of micronucleated polychromatic erythrocytes (MPCE) and normochromatic erythrocytes (MNCE) in the bone marrow and peripheral blood induced by multiple inhalations of 1,3-butadiene was observed in mice with a new automatic flow cytometric technique designed by the authoors themselves and the conventional flow cytometry. 1,3-butadiene of 0, 50, 200, 500 and 1 300 ppm was inhalated by the mice repeatedly for 5 days.

It was found that the incidence of MPCE and MNCE was significantly increased in both the bone marrow and peripheral blood after butadiene inhalation and the dosage-effect relation was non-linear. The slope of the curve was flattened when the exposure concentration of 1,3-butadiene was increased.

These findings suggest that 1,3-butadiene possesses definite genetic toxicity and it also exerts cytotoxicity red cells since there was a decrease of MPCE in number in the peripheral blood when the dosage of 1,3-butadiene was increased.

Key words 1,3-butadiene; toxicosis; mice; micronuclei; flow cytometry

论文摘要

放射损伤、烧伤和放烧复合伤早期心肌能量代谢和形态结构的变化及其机理研究*

Effects of radiation, burn and combined radiation-burn injuries on energy metabolism and morphology of myocardium and its mechanism

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放烧复合伤是核爆炸与平时核事故所发生的主要伤类之一。放烧复合伤早期心肌固有收缩力下降的机理尚待探讨。少数文献指出，鉴于烧伤后心肌细胞内高能磷酸化合物含量下降，能量代谢障碍可能是伤后心肌功能下降的重要原因。本实验以单一伤与复合伤相对比检测能量代谢功能变化并与形态病变相联系，观察伤后变化与进行实验治疗(补液或使用钙通道阻滞剂)相引证，以心肌能量代谢的主要细胞器——线粒体为重点，并侧重从钙代谢方面探讨能量代谢变化的机理，以期为阐明放烧复合伤心肌损害及其机理提供实验依据。

用健康雄性 Wistar 大鼠，体重170～250 g。放射损伤的动物接受^{60}Co γ线全身一次照射，照射距离1.5 m，照射剂量6 Gy；烧伤的动物背部剪毛，乙醚麻醉下用5 kW 溴钨灯照射造成三度烧伤；放烧复合伤动物选照射后烧伤。补液量为45 ml/kg 生理盐水，烧伤后立即和12 h 分二次腹腔注射；每次为总量的1/2。钙通道阻滞剂用量为：4 mg/kg 维拉帕米，腹腔注射。

本实验的主要结果和结论如下：(1)放烧复合伤早期血压下降并致休克的发生中，烧伤是主要因素，放射损伤使血压下降更早、更重、持续更长。(2)6 Gy 全身照射、10%～30%三度烧伤与放烧复合伤时心肌线粒体呼吸功能和肌球蛋白 AATP 酶活力显著下降，复合伤时下降更显著。这说明伤后心肌细胞能量的产生和 利用均发生障碍。(3)三伤组心肌组织病变主要要表现为不同程度的退变，不同伤类无显著差异。心肌超微结构主要是肌膜下水肿，肌原纤维模糊，闰盘扩张、解离，线粒体局部空泡化、嵴稀疏、指纹样变，内皮细胞水肿和间质水肿。照射后线粒体肿胀较明显，这在线粒体图像定量分析中得到证实；而烧伤与复合伤时出现了闰盘扩张、解离等病变。(4)补液抗休克显著改善了烧伤和放烧复合伤时心肌细胞能量的产生和利用，保护线粒体结构或减轻损害。(5)放烧复合伤心肌线粒体游离钙含量升高，钙释放加速。补液或维拉帕米减少伤后线粒体钙含量和保护线粒体呼吸功能。提示伤后心肌线粒体呼吸功能损害与钙含量升高有关。(6)外源性钙离子对正常心肌线粒体呼吸功能有双重作用：低浓度钙刺激呼吸；高浓度钙抑制呼吸，维拉帕米有一定的保护作用。外源性钙离子对放烧复合伤心肌线粒体呼吸功能为单向作用：低浓度无作用；高浓度抑制。

由此可见，伤后缺血缺氧可以导致细胞内钙含量升高，钙含量升高是导致线粒体功能损害的重要原因。

关键词 灼伤；辐射损伤；休克；线粒体；钙；心肌；大鼠

中图法分类号 R644，R818

* 全军"八五"攻关题分题，国家自然科学基金资助

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