CARDIOTOXIC EFFECT OF RESTRAINT STRESS AND NORADRENALIN IN STRESS SUSCEPTIBLE PIGS

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in this section.

Previous studies have documented, that myocardial necroses are developed in stress susceptible pigs during transports and slaughter handling. It was suggested that mental stress provoked by restraint techniques may induce heart necroses in pigs. High levels of catecholamine were registered in the blood plasma and ECG registration revealed ventricular arrythmias and tachycardia. The significance of mental stress was further supported by the fact that amygdalectomy modifies the response to the restraint stress as measured from catecholamine levels and pathomorphologic picture. It was also demonstrated that long-term treatment with the β-adrenoreceptor blocker propranolol protects against stress-induced myocardial necroses. Experiments were designed to obtain more complete information concerning the role of catecholamines in the development of myocardial necroses.

One group of eleven halothane sensitive and nine halothane negative crossbred pigs of Yorkshire and Swedish Landrace, six months of age, were used for restraint stress. Succinylcholine chloride, about 14 mg/kg/min, was administered during 12 minutes into the cranial vena cava. The infusion rate was accomodated so as not to interfere with the respiration of the animals. The other group of seven halothane sensitive and seven halothane negative pigs of the same age and breed was used for noradrenalin (NA) administration. Noradrenalin bitartrate was dissolved in saline solution and infused during 12-15 minutes with continuous ECG registration.

Serum samples for catecholamine determination were taken from animals which were exposed to restraint stress. The catecholamine levels were low at rest and marked increase in the halothane sensitive pigs during the stress period. The serum values significantly differed from those of the control group ($p < 0.05$), even ten minutes after the termination of the stress procedure.

The animals were euthanized 24 and 48 hours after the onset of restraint stress and NA infusion. Complete postmortem examination was performed with special attention to the heart. Myocardial tissue for histopathological and ultrastructural examination included the ventricular septum, the ventricular free walls and the atria. The morphological changes in the hearts were evaluated according to the point scale presented in Table 1.

Table 1. Point scale grading heart necrosis.

0: no necrosis
1: necrosis of individual myocardial cells in fewer than 50% of the slides
2: necrosis of individual myocardial cells in more than 50% of the slides
3: isolated foci of several necrotic myocardial cells
4: confluencing foci of necrosis
5: grossly visible areas of necrosis less than 5 mm in diameter
6: grossly visible areas of necrosis more than 5 mm in diameter

Macroscopical areas of confluent light necrotic foci were observed in five of the halothane sensitive animals in the restraint stress group and in five of seven susceptible pigs in the NA infusion group. Four pigs of the two control groups showed grossly visible lesions (Table 2). The myocardial necroses, which were patchy or confluent, tended to be located in the inner third of the left ventricle and, in some instances, involved almost the entire circumference of the ventricle. The lesions were demonstrated most sensitively macroscopically by incubating slices of myocardium in the presence of the dehydrogenase indicator nitro-blue tetrazolium. The necroses were mostly discernible to the naked eye as well demarcated pale foci.

Table 2. Extent of myocardial necroses after restraint stress and noradrenalin (NA) infusion in halothane positive (HP) and halothane negative (HN) pigs.

		Total number of pigs	Number of pigs with cardiac lesions graded according to point scale						
			0	1	2	3	4	5	6
Restraint stress	HP	11			1	1	4	3	2
	HN	9	2	3	1		1	2	
NA infusion	HP	7					2	4	1
	HN	7	1	2	1		1	2	

The characteristic microscopical alterations in the myocardial cell of both experimental groups were as follows: There was loss of definition of the linear arrangement of myofibrils with cross striations and the appearance of areas of dense eosinophilic transverse banding, alternating with granular zones within the cytoplasm. This characteristic alteration, named contraction band necrosis (myofibrillar degeneration), showed loss of the regular arrangement of the myofilaments. The ultrastructural analysis also revealed vesiculated sarcoplasmic reticulum and enlarged mitochondria with loss of cristae and electron-dense deposits of calcium salts. Polymorphonuclear leucocytes surrounding the injuried myocardial cells were scarce or absent. The cells, which were interspersed between the necrotic cardiac cells were represented by phagocytizing histiocytes and fibroblasts.

The contraction band necrosis described here resembled unreversed supercontraction of myofilaments and it was suggested that this could be due to intracellular calcium imbalance. Endogenous catecholamines released locally or delivered parenterally, when present at levels greater than the concentrations that normally produce their physiological actions, may be capable of causing injury to the cell's membrane systems.

Selected references: Huckell, V.F., H.M. Staniloff, B.A. Britt, M.B. Waxman and J.E. Morch: Circulation 1978, 58, 916; Johansson,G. and L. Jönsson: J. Comp. Pathol. 1977, 87, 67; Reichenbach, D.D. and E.P. Benditt: Hum. Pathol. 1970, 1, 125.

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