Institut für Pathologische Physiologie der Universitätsklinik Essen (GHS)

Maximum contractility of the experimentally hypertrophied heart in situ and survival of the acute coronary occlusion

Maximales Kontraktilitätsverhalten experimentell hypertrophierter Herzen in situ und die Überlebensrate nach akuter Koronarokklusion

K.-O. Bischoff, W. Meesmann, and K. Stephan

With 3 figures and 3 tables

Summary

Studies were carried out in dogs with significant moderate left ventricular hypertrophy (LVH) induced by artificial coarctatio aortae to reveal the reserve of performance and the behavior in response to acute ligation of the LCA (left circumflex artery). The hemodynamic data at rest and during catecholamine stimulation were not essentially different, whereas the maximal inotropic state was a little enhanced in LVH dogs (LVH = 12; CG = 6). The acute maximal pressure rise of the left ventricle - obtained by acute clamping of the aorta ascendens - was nearly the same in both groups (LVH = 6; CG = 6) when related to 100 g left ventricular wet weight. The LVH hearts react to a rapid volume overload with a slightly higher increase of HR and LVEP indicating a minor adaption to an acute volume overload explained by diminished compliance. In consequence to acute ligation of the LCA (LVH = 13; CG = 11) LVH hearts showed a higher (p < 0.05) survival rate (69%) than controls with comparable collateral status of the coronary collateral vessels because 91% of these developed ventricular fibrillation. To explain this phenomenon we determined the catecholamine-concentration in each part of the heart in a further group (LVH = 5; CG = 6). Unexpectedly a significant diminution was seen in the non-hypertrophied right ventricle, but the other compartments also showed a decrease of the catecholamine concentration. Subsequent studies have to be done to explore the better electrophysiologic protection of the LVH heart in consequence to acute ligation of the LCA.

In recent years considerable efforts have been made by different investigators to describe and evaluate the chronic pressure-loaded hypertrophy of the heart (2, 6, 8, 9). The results of the different groups are inconclusive. The effect of hypertrophy on the performance and the reserve of contractility of the intact heart in situ is still a matter of dispute. We feel that the extent of hypertrophy and the type of experimental preparation appears to be essential when one deals with the question of whether there is a different functional behavior of chronic pressure-overloaded hearts in
response to different acute loads compared to controls. In the present study moderate left ventricular hypertrophy (LVH) was produced in dogs by chronic aortic constriction in order to examine the following questions on the heart in situ:

1. Is the maximum contractility - expressed as \((dp/dt)_{\text{max}}\), \(t-(dp/dt)_{\text{max}}\) and \(V_{\text{pm}}\) in dogs with LVH different from a control group?

2. Is there a significant difference in maximum left ventricular pressure during acute aortic clamping or in reaction to a rapid volume overload in comparison to a control group?

3. Is there a difference in the survival rate following acute occlusion of the left circumflex artery (LCA) between animals with left ventricular hypertrophy and animals without? Both groups met the requirements of the same coronary collateral vessel status.

**Methods**

40 adult mongrel dogs were prepared for coarctatio aortae during aseptic thoracotomy under anesthesia. A hygroscopic casein cylinder block sleeved by stainless steel was placed around the upper part of the aorta descendens. This prosthesis constricted a mean of about 60% of the lumen of the aorta.

18 of the 40 dogs which survived the coarctation minimum period of 140 days were studied from 144 up to 218 days after operation and compared to a control group of 17 animals with comparable body weight.

The experiments were performed under standardized conditions. Anesthesia was carried out with piritramid and nitrous oxide using artificial respiration.

The heart rate (HR), electrocardiogram, left ventricular (LVP) and aortic pressure (AoP, AoPd), measured by two high-fidelity Millar-catheter-tip-manometers were recorded continuously by a high-speed Honeywell-UV-Recorder.

The "so-called" paramters of contractility - that is \((dp/dt)_{\text{max}}\) and peak measured velocity - expressed as the ratio of \(dp/dt\) to instantaneous left ventricular pressure - were derived continuously from left ventricular pressure by a differentiator.

In 12 dogs with coarctatio aortae and 6 controls the maximum of contractility - defined by maximal obtained \((dp/dt)_{\text{max}}\) - were stimulated by stepwise-increasing doses of combined infusion of isoproterenol and norepinephrine. In earlier investigations we recognized that the heart rate and afterload were nearly constant if the proportion of isoproterenol to norepinephrine was 1:10. The cardiac output was measured by thermodilution. These in situ experiments were done by closed, the following investigations by open chest.

By means of a reversible silk tourniquet, in 6 dogs with left ventricular hypertrophy and 6 control dogs the ascending aorta was occluded acutely and the maximal LVP was measured twice. In these animals the acute volume overload was done by a rapid dextrane (6%) solution injected into the right atrium, with a velocity of 100 ml/min, the total injected volume was 1400 ml.

One to two hours thereafter the left circumflex artery (LCA) was occluded acutely in 13 coarctated dogs and 11 controls. The development of ventricular ectopic beats and the latency - determined as the time from occlusion till the onset of ventricular fibrillation - were monitored in both groups when they occurred.

In 5 animals with coarctatio aortae and 6 control dogs myocardial catecholamines in each part of the heart were assayed spectrofluorometrically by the trihydroxy-indole method according to van Euler and Lishajko as modified by Anton and Sayre (1).

24 hours post mortem, a selective coronary angiography was performed to reveal the extent of the collateral vessels of the heart. In a former study the results from