# PROCEEDINGS

## OF THE INTERNATIONAL UNION OF PHYSIOLOGICAL SCIENCES

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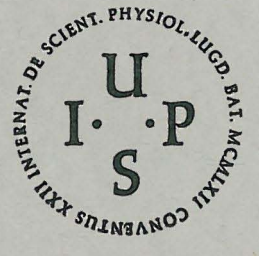

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We have studied the relationship between cycle length and contractility in isolated intact rat hearts, perfused according to Langendorff. Contractility is defined as recorded amplitude of isotonic contractions.

Experimental evidence has been presented that in vitro there exists a characteristic relationship between frequency and steady state contractility (Fig. 1).

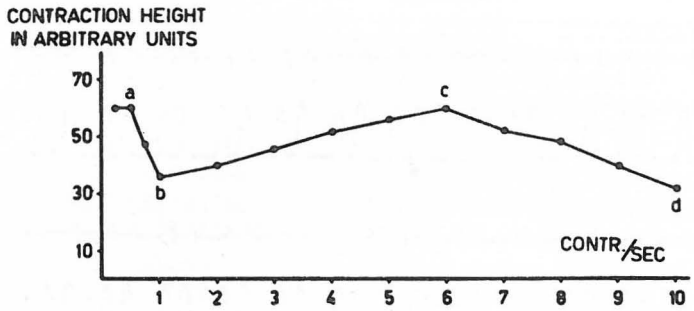



*Figure 1*

This relationship (the so called 'triphasic curve') implies that, under constant experimental conditions, for each frequency there is a corresponding contraction height.

It was also found that mean contractility is constant at a certain frequency whether the rhythm is regular or not.

In Fig. 2 at a *constant* net rate the regular rhythm (upper row) gradually changed into a bigeminy with varying coupling.

In each row the sum of the heights of the contractions is constant. These two important phenomena can explain the occurrence of a post-extrasystolic increase of contraction height following a premature beat and a compensatory pause. When a premature beat is followed by a compensatory pause, the mean frequency does not change and thus mean contractility is kept constant.

This is demonstrated very well in Fig. 3, which shows the sum of the contraction heights of the extrasystolic and the post-compensatory beat, and two times the amplitude of a normal foregoing contraction.

As demonstrated by Dr. DURRER, this increase of contractility following a premature beat and a compensatory pause, is different from potentiation following an interpolated premature beat.

In our experiments there is only a slight quantitative difference between potentiation following an interpolated premature beat and so called post-stimulation potentiation.

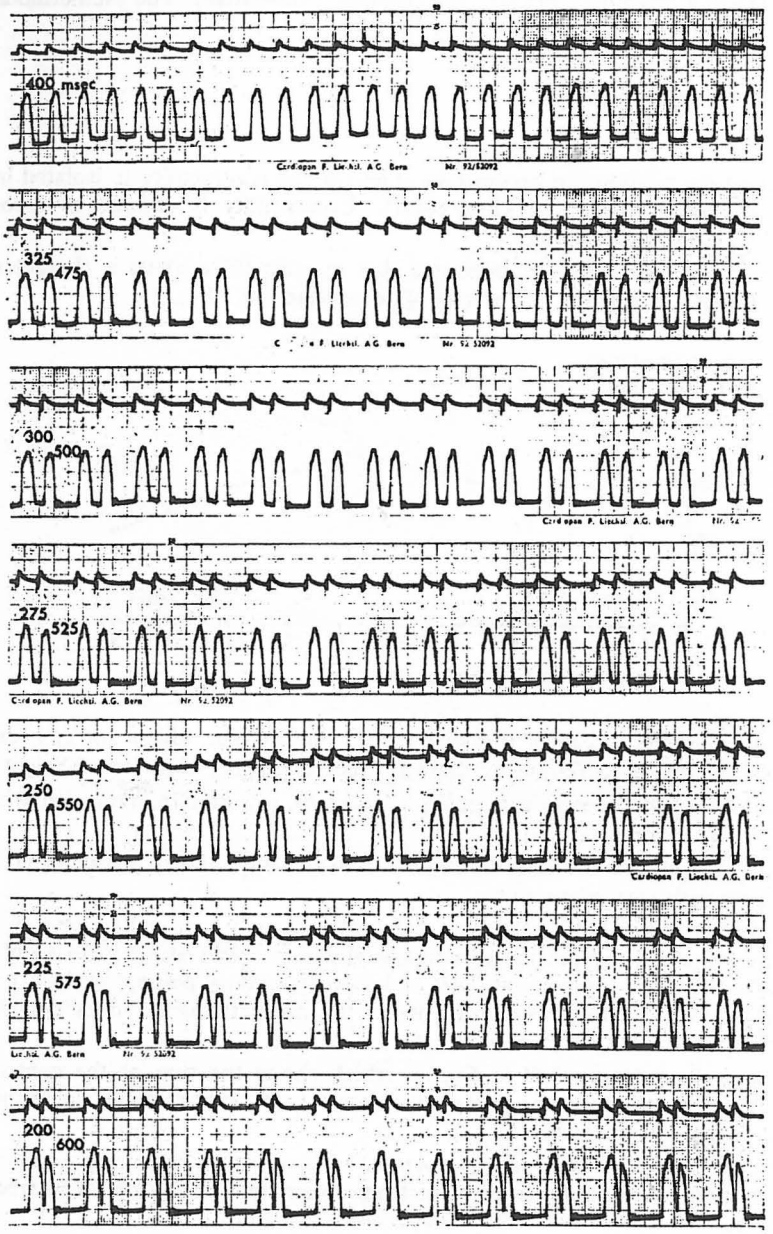
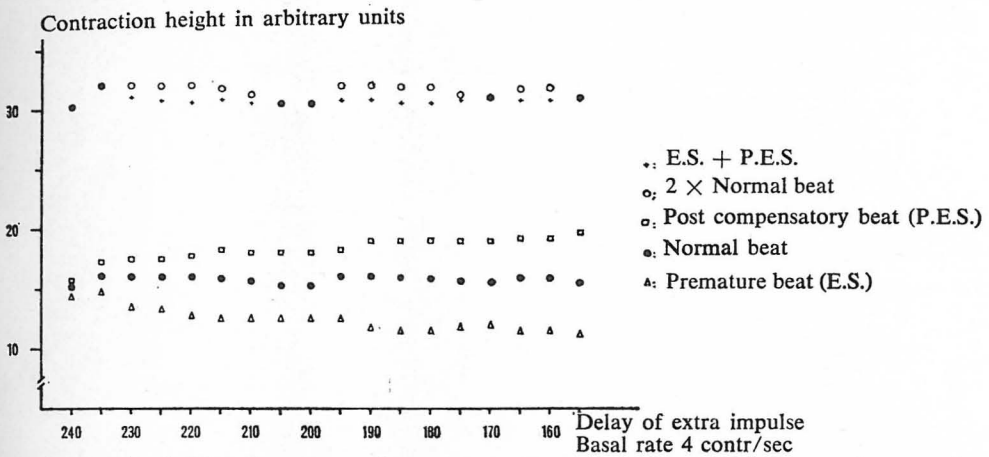



*Figure 2*

In both cases the increase in amplitude disappears with a 'decay'. Insufficient attention has been paid to the mirror-image pattern of post-stimulation potentiation of contractility at the beginning of a lowered frequency and the decrease in amplitude of contractions at the beginning of an increase in frequency. In Fig. 4 it can be seen that the sum of the height of the first contraction of the increased rate and the height of the first contraction of the decreased rate amounts to 26 mm., which is equal to the sum of heights of contractions at each of the two frequencies in the steady state. The




Contraction height of premature, beat post compensatory contraction and normal contraction

*Figure 3*

same applies for the sum of the second contractions, the third, etc. Thus, the height of the first beat of the high rate has diminished to the same extent as the amplitude of the first contraction of the low rate has increased.

The decrease in amplitude following a shorter interval is attributed to restitution, whereas post-stimulation potentiation is said to be caused by another mechanism.

With regard to our data, restitution and potentiation can be described by the same process. The velocity of restitution is constant in the steady state with a certain (regularly spaced) frequency. In the middle portion (b-c) of the triphasic curve velocity of restitution is increased when frequency is increased and is diminished when the rate diminishes. There is no reason to postulate separate mechanisms to explain changes in contractility induced by changes in cycle length.

It is possible to explain and to predict responses of contractility to changes in cycle length by considering the following data:

(a) constant mean contractility at a constant mean frequency,
(b) a characteristic relationship between frequency and contractility in the steady state,
(c) the time course of restitution.

We therefore conclude that cycle length is just one of the intrinsic factors which regulate cardiac performance.

Limited by time, we elucidated only a few aspects of this factor. Studying the metabolic process(es) which intermediate(s) between cycle length and cardiac performance is an ambitious goal for future experiments.

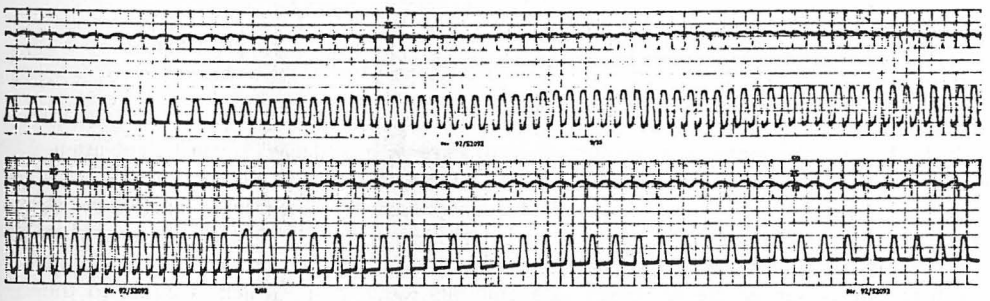


*Figure 4*