# Distribution of Catecholamine in the Dog Heart.* (28152)

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The neurohormone of the sympathetic nerve endings in the heart is believed to be norepinephrine although tissue analysis reveals the presence of relatively small amounts of epinephrine as well(1-3). With few exceptions(4), authors have reported catecholamine contents of the heart without specific designation of the portion of the organ from which the tissue was removed.

In an attempt to correlate functions of the 4 chambers of the heart with actions of the right and left sympathetic nerve supply, the specific content of catecholamine in each of the chambers and the septum was determined. Since such data are not readily available in the pertinent literature, these comparative values in the normal dog are reported here.

*Methods.* In 8 animals anesthetized with sodium pentobarbital (30 mg/kg), the chest was opened and the heart rapidly removed and washed free of blood. Duplicate tissue samples were taken from both atria, both ventricles and the septum. The samples were rapidly frozen on dry ice and retained in the frozen state until analyzed. Duplicate analyses were made on each tissue sample using the trihydroxyindole fluorimetric method(5). Although some effort was made to analyze for epinephrine and norepinephrine separately, the data are recorded here as total catecholamine, *i.e.,* norepinephrine plus epinephrine (calculated as norepinephrine equivalents). It has been shown, however, that norepinephrine constitutes about 90% of the total catecholamine in cardiac tissue.

*Results.* In Table I the catecholamine levels of 5 different regions of the dog heart are shown. Each value represents an average of 4 different determinations made on 2 tissue samples taken from each region and is reported as micrograms per gram of wet tissue. It is clear from these data that a distinct and significant difference exists in the catecholamine content of the atria as compared with that of the ventricles ($p = < 0.001$). In most of the hearts the content of the right ventricular free wall was slightly higher than that of the septum. In 2 hearts the catecholamine level was considerably higher in the left atrium than in the right, but in the majority of specimens, it was distinctly higher in the right atrium. Similarly, levels were generally somewhat higher in the right than in the left ventricle. However, the significance of these differences was not borne out by statistical analysis.

*Discussion.* It is apparent that important differences in catecholamine content exist within the different myocardial regions of the heart. The large superficial coronary arteries were avoided in taking the tissue samples; however, the precise histological distribution of norepinephrine in the heart is not known. Neither is the storage state of the material understood. It is important, however, that our average values correspond well with those of others(6).

Since norepinephrine is thought to be released at the sympathetic post-ganglionic endings in the myocardium, it follows that proper assay of this chemical agent should give important insight into the specific distribution of the adrenergic nerve fibers to the heart. The relatively high concentration of catecholamine in atrial tissue corroborates histological descriptions of sympathetic distribution. In view of the profound chronotropic activity of the sympathetic nerves with maintenance of a sinus rhythm, it is not surprising that a high concentration of the hormone was found in the right atrium. It is possible that a small tissue sample removed from the immediate vicinity of the S-A node would show an even higher concentration. Similarly, a high concentration in left atrial tissue suggests nearly as profuse a distribution of fibers to this region of the heart. The occurrence of

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TABLE I. Catecholamine Content of Dog Heart (expressed as μg/g).

| Dog No. | Wt of dog | Right atrium | Left atrium | Right ventricle | Left ventricle | Septum |
|---|---|---|---|---|---|---|
| | (kg) | | | | | |
| 1 | 25.5 | 1.29 | .72 | .42 | .34 | .29 |
| 2 | 20.0 | 1.53 | .75 | .60 | .56 | .50 |
| 3 | 12.5 | 1.44 | 1.82 | .77 | .87 | .70 |
| 4 | 12.5 | 1.62 | 1.40 | .81 | .43 | .49 |
| 5 | 10.0 | 1.24 | 1.22 | .88 | .84 | .90 |
| 6 | 10.0 | 1.28 | 1.44 | .82 | .72 | .71 |
| 7 | 13.0 | 1.11 | .76 | .90 | .49 | .79 |
| 8 | 9.5 | 2.15 | .93 | 1.21 | .74 | 1.00 |
| Avg | | 1.46 | 1.13 | .80 | .62 | .67 |

marked augmentation in force of contraction of both atria during stellate ganglion stimulation is clearly demonstrated in the elevation of the A-waves and represents a direct atrial myocardial response to stimulation(7-8).

The concentration of catecholamine in the ventricular walls is approximately 50% of that found in the atria, when reported as micrograms per gram of wet tissue. Presumably, this denotes a lesser density of sympathetic nerve endings in ventricular tissue. However, the fact of powerful augmentation in force of ventricular contraction as a result of stellate ganglion stimulation establishes the importance of this adrenergic innervation.

The lowest concentration observed in the entire heart was often found in the septal wall. If the above logic is sound, this indicates that the distribution of adrenergic fibers to the heart is most sparse in this region. In view of the remarkable acceleration of conduction time generally attributed to sympathetic nerve stimulation, this finding was somewhat surprising. It appears from these findings that the greater synchrony in contraction of muscle segments throughout the heart concurrent with sympathetic stimulation is related to a closer coupling between electrical excitation and mechanical contraction in each local area of the heart rather than to acceleration of conduction time.

An analysis of the data reveals that there appears to be an inverse correlation between the size of the dog and the concentration of catecholamine (expressed as micrograms per gram of tissue). If this is true, it indicates that in an animal having a larger heart, the sympathetic nerve endings may be more diffusely distributed throughout the myocardial tissue than in an animal with a smaller heart.

*Summary.* The total catecholamine content in each of the chambers of the heart and the septum was determined by fluorimetric analysis. Values for the control dog are reported.

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