ATRIAL STRETCH receptors have been located in both the right and left atria in a variety of species. Two types of atrial receptors whose fibers traverse the vagus have been identified by Paintal, who termed them type A and type B on the basis of the timing of their discharge in relation to the cardiac cycle. Their discharge characteristics have been investigated by several workers and these receptors have been implicated in reflexes that may be involved in the control of fluid and electrolyte balance, heart rate, and systemic resistance. During clinical episodes of atrial tachyarrhythmias such as atrial fibrillation and paroxysmal atrial tachycardia, a pronounced polyuria is often exhibited, lasting in some cases longer than the paroxysm. Although atrial pressure is often elevated during these episodes, the contribution of increasing heart rate per se to atrial receptor discharge has been investigated by only one group of workers; however, in their study a quantitative analysis of discharge in relation to changes in atrial pressure was not made. Furthermore, the frequency of discharge was not correlated with left atrial pressure (LAP). Therefore, our present study was undertaken to quantify the discharge of type B atrial stretch receptors in response to alterations in heart rate over a wide range in the dog.

Methods

Six mongrel dogs of either sex, weighing between 15 and 25 kg, were anesthetized with pentobarbital sodium...
Results

Figure 1 illustrates the response of a type B left atrial receptor to increasing heart rates. This animal previously had been given a total of 400 ml of warm isotonic saline intravenously to elevate discharge so that the effects of increasing heart rate would be evident. When heart rate was increased to 120 beats/min (upper right hand panel) LAP fell, aortic pressure rose, and atrial receptor discharge decreased (in terms of discharge per cardiac cycle). With further increases in heart rate, receptor discharge continued to decrease (lower panels). Aortic pressure remained constant and LAP fell at 150 beats/min. Discharge decreased further at 190 beats/min. However, because of the short time available for atrial filling, the peak "v" wave of the LAP pulse is difficult to ascertain in this tracing. In any event, it is clear from this figure that the number of spikes per cardiac cycle fell as heart rate was increased.

In addition to the number of spikes per cardiac cycle, an important component of neural information processing may be the instantaneous frequency of the receptor discharge.
The present experiments indicate that there is an inverse relationship between the activity of type B atrial receptors and heart rate so that over a broad range of heart rates the discharge per minute does not change significantly. In association with the increase in heart rate, both LAP and the time for atrial filling decreased. Our hemodynamic observations are consistent with the recent report of Stone, who demonstrated a decrease in left atrial end diastolic diameter with increases in heart rate of up to 50 beats/min in conscious dogs. That the duration of atrial filling influences atrial receptor discharge is substantiated by the recent work of Arndt and co-workers, who used isolated strips of atrial tissue in the cat with the receptors still intact. While keeping the amplitude of stretch constant they demonstrated a hyperbolic relationship between spikes per cycle and stimulus frequency between 1 and 10 Hz for both type A and B receptors, but the average discharge rate (spikes per second) remained constant over this range of frequencies. These results are essentially in agreement with those of our present study although, unlike Arndt et al., we found no influence of stimulation frequency on the peak instantaneous frequency.

\[ Y = 1.83X - 16.3 \]
\[ r = 0.85 \]

Figure 3. The relationship between discharge in spikes per cardiac cycle and left atrial peak "v" wave pressure at the heart rates indicated by the different symbols.
of type B receptor discharge except at extremely high frequencies of stretch. Previous work from our laboratory\(^{18}\) indicated that at moderate heart rates left atrial type B receptor discharge did not show a significant velocity component but did correlate with the peak "v" wave of LAP and with atrial segment length. However, other workers\(^{12-21}\) have demonstrated velocity components of varying intensity, particularly when they used intense forcing functions. In a recent study Recordati et al.\(^{22}\) concluded that atrial type B receptors in the cat exhibited a substantial velocity component. Their conclusions were based largely on the observations that receptor discharge correlated better with the rate of change of tension developed during atrial filling than with the mean tension, and that the frequency of discharge was higher during dynamic pressure and length changes than during static changes. Since they used the mean discharge rate per burst for assessing dynamic length and pressure changes instead of the instantaneous frequency, it is not possible to conclude whether the slope of the length and pressure changes or the level of peak length and pressure change is the predominant determinant of discharge rate. In our present study the instantaneous frequency of discharge was maximal at the peak of the "v" wave of the LAP pulse. As heart rate was increased the rate of change of filling pressure increased while peak "v" wave pressure decreased, yet the maximal frequency remained constant or decreased slightly (Fig. 2). These results would indicate that if there is a velocity component to atrial receptor discharge it seems to be negligible, a finding in agreement with our previous results.\(^{18}\)

Lloyd\(^{12}\) has shown that stimulation of pulmonary venous
The response of atrial stretch receptors to increases in heart rate in dogs.
I H Zucker and J P Gilmore

Circ Res. 1976;38:15-19
doi: 10.1161/01.RES.38.1.15

Circulation Research is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX 75231
Copyright © 1976 American Heart Association, Inc. All rights reserved.
Print ISSN: 0009-7330. Online ISSN: 1524-4571

The online version of this article, along with updated information and services, is located on the World Wide Web at:
http://circres.ahajournals.org/content/38/1/15

Permissions: Requests for permissions to reproduce figures, tables, or portions of articles originally published in Circulation Research can be obtained via RightsLink, a service of the Copyright Clearance Center, not the Editorial Office. Once the online version of the published article for which permission is being requested is located, click Request Permissions in the middle column of the Web page under Services. Further information about this process is available in the Permissions and Rights Question and Answer document.

Reprints: Information about reprints can be found online at:
http://www.lww.com/reprints

Subscriptions: Information about subscribing to Circulation Research is online at:
http://circres.ahajournals.org/subscriptions/