Studies on the Adaptation Rate and Frequency Distribution of Type A and Type B Atrial Endings in Cats

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Summary. Since from the study of location no clue could be found regarding the difference in discharge patterns of type A and type B endings in cats, two separate series of experiments were performed. In the first series, the responses obtained from types A, B and intermediate endings on stretching the isolated atrial chamber were identical. From the second series directed to the frequency distribution of atrial endings and performed by recording of the neural activity in single fibres of the whole vagus, a ratio of 1:1 between type A and type B endings was found. Endings with an intermediate pattern of discharge were rare. Out of 71 atrial endings recorded from 4 vagus nerves, only 7 were of this type. These studies showed that:

1. The types A, B and intermediate endings are slowly adapting,
2. The intermediate type is a variant of type B, and
3. Type A and type B endings belong to different types. It is speculated that the difference in discharge patterns of type A and type B endings may be due to their arrangements in the atria.

Key words: Atrial type A endings - Atrial type B endings - Intermediate type atrial endings - Adaptation rate of atrial endings - Frequency distribution in atrial vagus fibres.

INTRODUCTION

Two types of sensory discharges originating from the atria have been reported and called type A and type B (Paintal, 1953, 1963). The difference in their discharge patterns has been attributed to different reasons. Arndt et al. (1974) suggested that a difference in the location in the atria may explain the two types of discharge patterns. They expected that type A endings might be located in the atria and type B in the veins. This implies that the same receptor behaves differently depending on its location. My own observations (Gupta, 1977) could not support this view. Another possible explanation given for the difference is the rate sensitivity of the endings which was suggested by Struppler and Struppler (1955). These workers explained the difference on the basis of adaptation properties. The adaptation rate of atrial endings was studied by Arndt et al. (1974) in isolated atrial strip preparations. The walls of the heart are constituted by elements such as muscle fibres orientated in different directions. So it was thought that stretch applied to a strip in one axis may not be transmitted to all the elements equally at the same rate. Accordingly, the amount and rate of stretch transmitted to any sensory element situated among or on these elements may not be indicated by the monitored tensions or changes in length so that a comparison of the nerve endings situated in different positions may not be strictly valid. Therefore it was decided to compare these results with in situ studies.

Further, some workers believe that the atrial endings belong to the same homogeneous population. This would mean that the intermediate type of endings would be more than the pure variants i.e., type A and type B. So the frequency distribution of each type of atrial ending was studied in a separate series by recording the activity in single fibres of the whole vagus nerve. The frequency distribution of a type of ending was taken as the number of the fibre of that type of ending in a given whole vagus.

MATERIAL AND METHODS

A. Study of Adaptation Rate

Experiments were performed on cats of either sex. The methods of preparation of the animals, recording of action potentials, ECG,
and localization of the endings were the same as described elsewhere (Gupta, 1977). In this study first an atrial fibre was dissected out in the cervical vagus of a cat with an intact chest. Then the thorax was opened and an isolated atrial preparation was made. Saline mixed with heparin (Biological Evans, India) was injected into the isolated atrium in order to stretch it. The temperature of the fluid was maintained at 37°C.

Preparation of the Isolated Atrial Chamber. Preparation of the isolated atrium was made by tying the inlet and outlet vessels. In the case of right atrium, a stout ligature was put around the superior and inferior venae cavae, azygos vein and atroventricular junction. The left atrial preparation was made by tying the pulmonary veins and atroventricular junction. In some endings on the right side, which were lying close either to the atroventricular junction or coronary sinus, tying at the atroventricular junction abolished the neural activity. In those cases the ligature was placed a little below the a-v junction. Because of its location, the left atrial chamber was more difficult to prepare than the right atrium. Therefore, a majority of the experiments were done on right atrial endings. The catheter for injecting fluid was placed in the chamber either through a slit in the appendage or through the systemic veins.

Receptor Response on Stretching the Isolated Atrium. The adequate stimulus of the receptors varied with the size of the atrium. Injection of saline had no effect until the amount reached the threshold value. With volumes above threshold level, the endings produced a discharge, the peak frequency of which was recorded during the dynamic phase of the stretch, viz. the period of injection. Later the discharge settled down to a steady level with a reduced and constant frequency. This steady discharge remained as long as the pressure was maintained.

Pressure Recording. Atrial pressure was recorded through a semi-rigid polyethylene catheter, 10 cm long and 2 mm wide. The catheter was passed into the respective atrium through a slit in the appendage; then the slit was tightly ligated. The other end was connected to the pressure transducer (Statham P 23 Db).

B. Frequency Distribution of Each Type of Atrial Endings

In this series the activity from single fibres of the vagus nerve was recorded and thus a chance of getting a particular type of ending was attained. Preparation of the animals and recording techniques were the same as described above.

RESULTS

Adaptation rate in 20 atrial endings was studied. Of these 13 were of type B, 6 of type A and 1 of intermediate type. As an illustration of the response from each type of ending, typical response to stretch of a type B, A and intermediate ending is described. Figure 1C1—C2 shows the response from a type B ending which is slowly adapting. The type B endings do not show any impulse during the atrial systole under normal in vivo conditions. However, in isolated preparations, contraction of the atrium elicited impulses (Fig. 1B). Atrial contraction also modified the process of adaptation (Figs. 1C1—C2 and 4). The frequency of discharge rose rapidly with the increase in intra-atrial pressure following contraction and fell off during relaxation to a lower level. In Figure 4 the average frequencies are plotted. The average frequency was taken as the average reciprocal of 5 spike-to-spike intervals.

Figure 2C1—C2 shows the response from a type A ending which is similar in nature to the type B response. In the normally beating heart, type A endings do not show any discharge during the atrial filling phase of the cardiac cycle. Also intravenous injection of fluid in vivo does not have any effect on the discharge pattern. But type A endings in isolated in situ preparations showed a similar response to type B endings on stretching. Above a threshold level of stretch, these endings gave a lasting and slowly adapting discharge (Figs. 2C1—C2 and 4). During the atrial contraction, impulse discharge was seen both in the filled and empty isolated atrium (Fig. 2B). Contraction of the atrium had a marked effect on the adapting discharge (Figs. 2C1—C2 and 4). In Figure 4 the average frequencies