Double Wenckebach phenomenon in atrioventricular node and His bundle

Electrophysiological demonstration in a case of atrial flutter

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SUMMARY In a case of atrial flutter with a 9:2 atrioventricular response, the only possible way to explain the conduction pattern was 3:1 block in the atrioventricular node (which is 3:2 Wenckebach sequence in the N zone and a 2:1 block at the junction of the node with the bundle of His) plus 3:2 Wenckebach sequence distal to the H deflection. The recording of the His bundle deflection confirmed this analysis.

We have recently¹ suggested a way to analyse conduction through the atrioventricular node in cases of atrial flutter with so-called irregular ventricular response. According to this concept, three levels of conduction are presumed to be present in the AV node: an upper level (atrio-nodal junction), in which there is either 1:1 or 2:1 conduction; a middle level (N zone, in electrophysiological terms) with decremental conduction and Wenckebach phenomena: 10:9, 9:8, down to 2:1 conduction; and a lower level (junction of atrioventricular node and bundle of His), in which there can also be 1:1 or 2:1 conduction.

In the present case report, we were able to analyse the atrioventricular conduction according to this concept, postulate that there was only one possible explanation for the phenomena, and confirm it afterwards with His bundle recordings.

Case report

A 71-year-old man was admitted to our unit for atrial flutter. He had not received any antiarrhythmic drug before admission. The electrocardiogram showed classical atrial flutter (Fig. 1) with a PP interval of 210 ms. The ventricular rhythm was slow and irregular, but always with the same sequence: a relatively short RR interval of 790 ms which is longer than three PP intervals ($3 \times 210 =$

630), but shorter than four PP intervals ($4 \times 210 = 840$), followed by a relatively long RR interval of 1100 ms. The sum of two consecutive RR intervals was 1890 ms, which is exactly equal to nine PP intervals ($9 \times 210 = 1890$). This, of course, equates with a 9:2 atrioventricular response. According to our theory, there is only one way to explain this 9:2 ratio (Fig. 2a): a 3:1 block in the atrioventricular node, which, theoretically, corresponds to a 1:1 conduction in the upper level of the AV node; a 3:2 Wenckebach phenomenon on the middle level; and a 2:1 block in the lower level, plus 3:2 Wenckebach phenomenon in the bundle of His.

Fig. 1 Atrial flutter—slow ventricular response with a 9:2 ratio between the atrial and the ventricular rhythms.

The recording of the His bundle deflection (Fig. 3a) confirmed the diagram shown in Fig. 2a, showing that A waves 1 and 4 are each followed by a ventricular response, but the HV interval is longer after A4 than after A1; A7 is followed by a

Fig. 2a Theoretical diagram explaining this ratio: alternating Wenckebach phenomenon (type B) in the atrioventricular node; 3:2 Wenckebach period in the bundle of His. (b) and (c) are alternative but incorrect explanations (see text).

Fig. 3a Recording of leads III and VI and His bundle electrogram (HBE). A, atrial deflections (numbered: for explanation see text); H, His bundle deflection; v, ventricular activation. (b) His bundle electrogram during sinus rhythm shows block distal to the bundle of His (2:1 or 3:2). HV intervals are lengthened to 90 and 170 ms.

blocked H wave; the A waves 2, 3, 5, 6, 8, and 9 are blocked in the atrioventricular node, since they are not followed by a His deflection.

After atrial overdrive, sinus rhythm was restored, and depending on the small variations of the atrial rate, there was (Fig. 3b) either 2:1 or 3:2 ventricular response; the AH interval did not vary, but there was either 2:1 block below the His deflection, or 3:2 Wenckebach phenomenon below the H wave (HV=90 ms; HV=170 ms; no V deflection after the third H deflection).

On the basis of this electrophysiological study, and mainly because there was block distal to the bundle of His during sinus rhythm, we recommended implantation of a permanent pacemaker.

Comments

The purpose of the present case report is to show that, to explain a 9:2 atrioventricular ratio during atrial flutter, there was only one possible diagram, that shown in Fig. 2a.

To explain a 9:2 response, there are theoretically two other possibilities:

(a) Fig. 2b shows two periods of 3:2 conduction, as a Wenckebach sequence, within the atrioventricular node, and then 2:1 block in the bundle of His.

Under these circumstances the first RR interval of the 9:2 response is longer than four PP intervals, but this was not observed in our patient.

(b) In Fig. 2c, the diagram shows a 3:2 Wenckebach period in the upper part, 2:1 block in the middle part, and 3:2 Wenckebach sequence in the lower part of the atrioventricular node. This is unsatisfactory, as it implies decremental conduction in the upper and lower parts of the node, but not in the N zone, which is not in accordance with the electrophysiological observations to date. The recording of the His bundle deflection proved that Fig. 2c was unacceptable, since this implied that all non-conducted P waves were blocked in the atrioventricular node.

The theoretically correct diagram (Fig. 2a) was confirmed by the recording from the bundle of His

(Fig. 3a). After restoration of sinus rhythm by atrial overdrive, the rate-dependent 3:1 atrioventricular block in the atrioventricular node was abolished, leaving only the organic block below the bundle of His (3:2 or 2:1, depending on the PP interval during sinus rhythm).

Reference

- 1 Slama R, Leclercq JF, Rosengarten M, Coumel Ph, Bouvrain Y. Multilevel block in the atrioventricular node during atrial tachycardia and flutter alternating with Wenckebach phenomenon. *Br Heart J* 1979; **42**: 463-70.

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