ECG Quiz 23

CASSA
CARDIAC ARRHYTHMIA SOCIETY OF SOUTHERN AFRICA
A SPECIAL INTEREST GROUP OF SA HEART ASSOCIATION

ANSWER

Systematic analysis of the ECG:

1. **Rate and regularity:** a ventricular rate of 204 bpm (6 x 34 beats counted in this 10 second recording); regular except between third and second last beats. The last R-R interval is identical to all the other R-R intervals. The gap between third and second last beats is less than 2 R-R intervals.

2. **QRS complexes** are narrow, with normal axis of 60°.

3. **Atrial activity:** It is difficult to identify any P-waves. In the "gap" at the end of the recording there appears to be a deflection after the T-wave that may be positive in lead II but may also have a negative component leading up to the QRS. If this is a P-wave, the PR interval is quite long: 220ms (5.5 small blocks x 0.04s).

4. **ST and T-waves** are abnormal with ST depression in V2-V6. The T-waves are biphasic in V2-V6. One cannot exclude P-waves or atrial activity "contaminating" the ST and T. Of note is that the ST segment of the second last QRS is minimally affected.

In summary, the ECG shows a rapid supraventricular tachycardia (SVT) that is regular except for near the end.

FURTHER DISCUSSION

Working systematically through the differential diagnosis of SVTs (Figure 1) and the list of possible answers to this ECG Quiz, one can, by a process of elimination, work out the mechanism and diagnosis of this ECG.

A sinus tachycardia with a rate of over 200 bpm is physiologically impossible in this 60-year-old woman. The maximum possible sinus rate is approximately 220 – age. ST segment depression is always suggestive of myocardial ischaemia; however, it is a common finding in rapid SVTs in patients who have no coronary artery disease and no symptoms of ischaemia or angina. These ST/T abnormalities occurring only during the SVT usually do not require further investigations or coronary angiography. Interestingly, the ST segment of the second last QRS is minimally depressed. This marked difference compared to the previous beat suggests that this is a rate-related "electrical" effect rather than a consequence of myocardial ischaemia.

Atrial fibrillation (AF) can be excluded relatively easily because the majority of this ECG recording is perfectly regular. In AF with fast ventricular response rates, the rhythm may appear to regularise remarkably and may catch one out and lead one down the incorrect different diagnosis of regular SVTs. A careful check with callipers or marking the R-R intervals on paper confirms regularity. Furthermore, a ventricular response rate in AF of over 200 is most unusual.

Statistically, the commonest regular paroxysmal SVTs are the AV junctional dependent re entry tachycardias (AVJRT). Both (1) AV nodal re-entry tachycardia (AVNRT) in which the tachycardia is

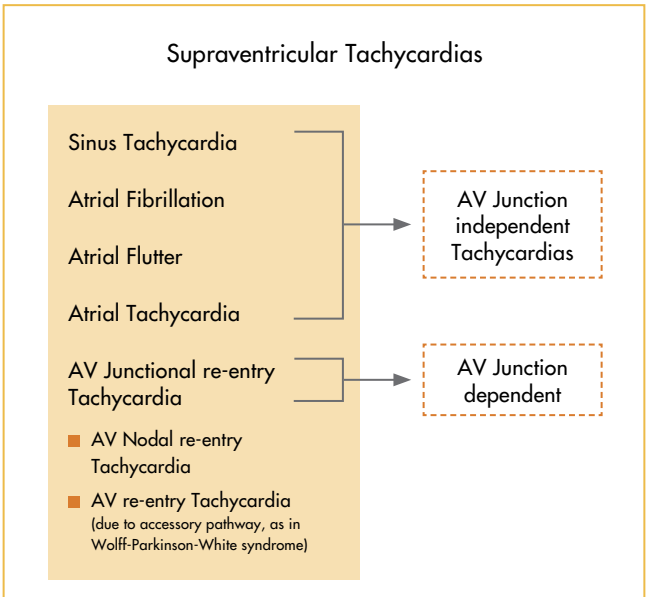

FIGURE 1: The common causes of Supraventricular Tachycardias in adults

limited to the AV node and its inputs (slow and fast pathways) and (2) atrioventricular re-entry tachycardia (AVRT) where the tachycardia involves the AV node and an accessory pathway are AVJRTs. When assessing any tachycardia and after establishing that it is regular and the QRSs are narrow, the next task is to look for atrial activity. Unfortunately, search for P-waves and atrial activity that is regularly associated with the QRS is often fruitless in AVJRTs and especially AVNRT, as the P-wave may be obscured by the QRS or T-wave. Difficulty in finding P-waves is itself a clue to this diagnosis. Nevertheless, these AVJRTs are characterised by a strict A-V-A-V sequence. A perturbation or disturbance of regular activity as seen near the end of the ECG is not in keeping with an ongoing re-entry using the AV junction. Could it be that the tachycardia stopped and then restarted? If so, an AVJRT may still need to be considered. Inspection of the "gap" reveals a deflection that is probable atrial activity with a P-wave in Lead II of the bottom rhythm strip that is initially positive and then negative – i.e. a very broad P-wave that is unlikely to be of sinus origin. If this is conducted, it is with an abnormally long PR interval of 220ms. Additionally, it would be rather odd for SVT termination to be followed immediately by a sinus P-wave without some sinus nodal pause. Also, if this SVT had terminated, and was followed by a sinus P-wave, the typical AVJRTs would not just restart in sinus rhythm but would require a triggering ectopic beat. There is no evidence of this here. The SVT is therefore not an AVJRT and the gap does not show a tachycardia termination.

By elimination and due to the persistence of the SVT despite the R-R gap near the end of the ECG, we need to consider the other SVTs that are independent of the AV node, namely, atrial flutter and atrial tachycardia.

Atrial flutter, unless it occurs in atria that are very large or atrial conduction velocity is slowed by antiarrhythmic drugs such as amiodarone (not ß-blockers), occurs in a narrow rate range of 250 to 350, and on average 300bpm in the atria. The ventricular response is typically 2:1 giving a heart rate of around 150. Occasionally, there may be 1:1 conduction. A rate of 204 as in this case, does not fit into either 1:1 or 2:1 atrial flutter.

So, we are left with atrial tachycardia (AT). The rate range of AT is very wide and 204 or faster is quite compatible. The AV conduction and ventricular response in AT can vary from 1:1 to various

FIGURE 2: ECG rhythm strip
The Lead II rhythm strip shows a regular R-R interval. The "gap" between the third last and second last QRS complexes is less than two R-R intervals. This finding is compatible with the pause noted in Wenckebach block.
The arrows point to a subtly changing positive deflection after the QRS complex. This deflection is not part of the QRS complex and represents the regular atrial rhythm. This changing relationship between the QRS/ventricular rhythm and the atrial rhythm followed by the "gap" is not compatible with AV junctional re-entry tachycardias. The atrial rate excludes typical atrial flutter. Therefore, the diagnosis is an atrial tachycardia which is not conducted 1:1 but with variable AV conduction which in this ECG is compatible with Wenckebach block with long periodicity.

types of second-degree heart block: Wenckebach, and variable AV block. When these blocks occur, the atrial rhythm persists undisturbed. The R-R gap is not exactly 2x R-R intervals. This is typical of "pauses" that occur in Wenckebach AV block. This ECG is compatible with AT with Wenckebach and very long periodicity, i.e. a long time elapses before the dropped QRS. If one inspects the quiz ECG very carefully, the upward deflection immediately after the small "s" of the QRS in the Lead II rhythm strip shows a gradual change as one moves from the left to the right side of the ECG until the R-R gap, only to repeat again after the gap (Figure 2). This probably reflects the very gradually prolonging PR interval before the Wenckebach related R-R gap.

Atrial tachycardias can be divided broadly into 2 groups: focal and re-entry. Focal or ectopic atrial tachycardias function similarly to sinus tachycardia. We, of course, know that sinus tachycardia does not terminate with electrical cardioversion (ECV), nor do true focal atrial tachycardias, but re-entry AT, just as any re-entry tachycardia, does terminate with ECV. In this patient having had previous mitral valve surgery, surgical scars can be found in her atria and have allowed a peri-scar macro re-entry atrial tachycardia, answer 1(e), with AV block due to variable AV conduction, answer 2(e).

The underlying atrial tachycardia can be confirmed by repeated ECGs hoping to "catch" further evidence of variable AV conduction or with a vagal manoeuvre to increase AV block and expose the atrial activity (Figure 3).

It is important to recognise this arrhythmia as it is often quite resistant to antiarrhythmic drugs but is amenable to ablation therapy.

CONCLUSIONS / LESSONS

- Systematic analysis of tachycardias, by a process of elimination of mechanisms, frequently leads one to the correct diagnosis.
- Management of haemodynamically stable regular SVTs involves searching for P-waves on the ECG, vagal manoeuvres to expose the P-waves, a drug such as adenosine to block the AV node and, if all of these fail, electrical cardioversion. Haemodynamically unstable tachycardias should be cardioverted urgently.
- In any tachycardia, perturbations or disturbances of the regular rhythm, are often the key to the diagnosis. So, look for them or cause them e.g. with vagal manoeuvre such as Valsalva or carotid sinus massage.
- Surgical scars in the heart should always make one consider scar-related re-entry tachycardias. Ablation therapy is the treatment of choice if these arrhythmias are recurrent.

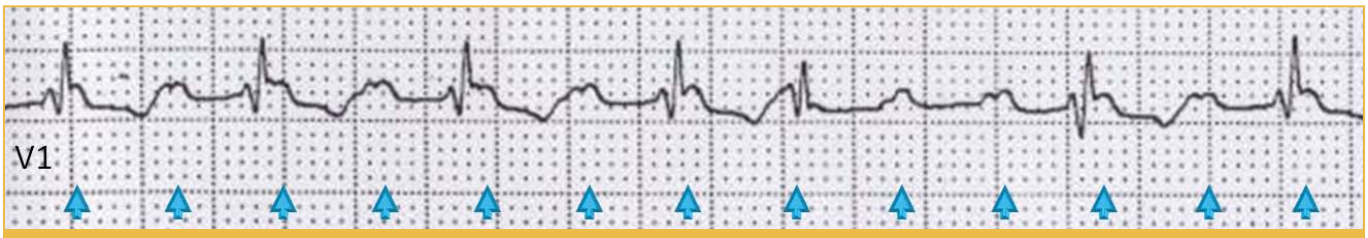

FIGURE 3: Atrial tachycardia with variable AV conduction
This ECG rhythm strip of Lead V1 that occurred spontaneously but may have also occurred with a vagal manoeuvre such as carotid sinus massage reveals the constant atrial rhythm with a cycle length of 280ms (7 small blocks x 0.04s) (equivalent to a rate of 214/min) with wide bifid P-waves. The ventricular response demonstrates variable AV conduction: if carefully analysed, Wenckebach phenomenon is apparent.

ECG and **QUESTION** on page 132