Tachyarrhythmias in Pre-excitation

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Tachyarrhythmias are common in patients with pre-excitation. Atrioventricular reciprocating tachycardias are the commonest. Atrial flutter and fibrillation are more frequent than in general population. Antegrade conduction over accessory path with short refractory period can result in very fast ventricular rate. Such patients are at risk of sudden death. Patients with pre-excitation can also have any other tachyarrhythmia. Surface electrocardiogram is helpful in identification of the nature of tachyarrhythmia. However, electrophysiological study may be needed for correct interpretation.

TACHYCARDIAS ASSOCIATED WITH ACCESSORY PATHWAYS

Patients with accessory pathways are susceptible to tachyarrhythmias. These tachyarrhythmias can be grouped as follows:

- When the accessory pathway is necessary for initiation and maintenance of tachycardia-atrioventricular reciprocating tachycardias.
- When accessory path allows rapid conduction during other supraventricular arrhythmias e.g., atrial fibrillation /atrial flutter.
- When the accessory pathway is only a bystander (Figure 1).

TACHYARRHYTHMIAS IN WHICH THE ACCESSORY PATHWAY IS NECESSARY FOR INITIATION AND MAINTENANCE OF TACHYCARDIA

Atria, atrioventricular node, His bundle, bundle branches, ventricular purkinje system and accessory path are involved in tachyarrhythmia. These are termed atrioventricular reciprocating tachycardias (AVRT). Atrio-ventricular pathways (Kent bundle) are frequently involved. Long atrio-fascicular paths can also produce AVRT. James fibers, nodoventricular and fasciculoventricular fibers do not participate in reentrant tachyarrhythmias.

AVRT can be:

- Orthodromic AVRT (about 95%)
- Antidromic AVRT (about 5%)

Orthodromic AVRT

A critically timed atrial premature beat, occurring after recovery of the A-V node from the effect of previous sinus impulse, traverses antegradely over the A-V node. His bundle resulting in normal depolarisation of ventricles producing a narrow QRS. After complete ventricular depolarisation, the impulse traverses retrogradely over the accessory pathway resulting in retrograde depolarisation of the atra. P wave, therefore, occurs after completion of QRS and is inverted in leads II, III and AVF. Contour of p wave differs from usual retrograde p wave because the atra

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TACHYARRHYTHMIAS IN WPW SYNDROME
A-V RECIPROCATING TACHYCARDIA

Ortho Dromic 70%
Anit Dromic 5%
Long R-P 2%
Multiple by pass tracts

ATRIAL FIBRILLATION (10-30%)

Orthodromic
Antidromic

ACCESSORY PATH AS BYSTANDER

Sinus Tachycardia
Atrial Tachycardia
AVNRT

Figure 1. Tachyrhythmias in pre-excitation

Figure 2 (A, B, C). Orthodromic AVRT with P wave (arrow) after QRS from three different patients

Figure 3 (A). Orthodromic AVRT with P inverted in lead I and aVL
(B). Sinus rhythm showing pre-excitation - left lateral accessory path

are usually activated eccentrically rather than from the low right atrial septum (Figure 2 a,b,c). A negative P in lead I suggests left sided accessory pathway resulting in atrial depolarisation from left to right (Figure 3 a, b). In case of septal accessory path, retrograde atrial activation occur from lower atrial septum. 'P' wave resembles classical retrograde activation.

On reaching the atria, the impulse again enters the AV node and is conducted antegrade to produce another narrow QRS and again a retrograde atrial depolarisation producing another inverted p wave after QRS. Activation of the circuit continues producing orthodromic AVRT. During tachycardia interval between

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preceding QRS and following p is less than the interval between p and next QRS. If retrograde conduction over accessory path is slow, distance between previous QRS and following P wave may be longer than distance between p and following QRS -Long R-p tachycardia (Figure 6 a,b,c,d). Such tachycardia may mimic atrial tachycardia. Sometimes p’ is not clearly visible and can result in depression of the ST segment. When this is seen during tachycardia mechanism of arrhythmia is most often re-entry involving an accessory pathway. Location of ST segment depression may suggest location of accessory pathway. ST depression in leads V3 to V6 suggests a left lateral path (Figure 4 a, b). Negative T wave in inferior leads suggests a posteroseptal or posterior path. Negative or notched T wave in V2 or V3 with retrograde p’ in at least two inferior leads suggests anteroseptal path. ST segment elevation in lead aVR also suggests AVRT.

Frequently retrograde conduction occurs over a concealed accessory path and preexcitation may not be apparent in sinus rhythm. Premature ventricular contraction can also initiate orthodromic AVRT. When there are two or more accessory connections, impulse may conduct antegradely over one accessory path and retrogradely over another accessory path. Orthodromic tachycardia may be difficult to distinguish from usual A-V nodal reentrant tachycardia. Heart rate higher than 200/min, with QRS alternans and a clear retrograde p wave in the ST segment support possibility of AVRT (Figure 7 a,b,c).

Sometimes a posteroseptal pathway conducts only retrogradely. If this retrograde conduction is slow it can produce permanent junctional reciprocating tachycardia. Such a tachycardia is incessant and responds only to ablation of accessory pathway.

Antidromic AVRT  
Antidromic AVRT involving a Kent bundle

Uncommonly either the refractory period of the accessory path is shorter than that of A-V node or the atrial ectopic arises in close proximity to the atrium.
proximity of accessory path. In these circumstances, the atrial premature beat conducts rapidly antegrade over the accessory pathway producing preexcitation of a part of either ventricle. This results in a delta wave producing a broad QRS complex. Impulse then enters the normal ventricular conduction system and is conducted retrogradely over the His-bundle and AV node to reach the atria. The impulse faces normal delay in conduction through the A-V node with the result that P'comes after completion of QRS. As the atria are depolarised retrogradely from the A-V node, P' is inverted in leads II, III aVF. The impulse then again enters accessory pathway establishing a circus movement with broad QRS tachycardia. (Figure 8 a,b, Figure 9 a,b). Antidromic AVRT is rare and occurs mostly with left sided bypass tracts. It is difficult to differentiate from ventricular tachycardia.

**Figure 7(A).** Orthodromic AVRT with a rate around 300/minute  
**B.** ECG during sinus rhythm showing pre-excitation  
**C.** Orthodromic AVRT showing electrical alternans

**Figure 8 (A).** Broad QRS tachycardia  
**(B).** Sinus rhythm from same patient showing pre-excitation

**Figure 9 (A).** Broad QRS tachycardia  
**(B).** Sinus rhythm from same patient showing pre-excitation

**Antidromic AVRT involving atriofascicular bypass tract**  
Atriofascicular bypass tracts can also participate in antidromic AVRT. These fibers connect low right atrium (area adjacent to the lateral tricuspid annulus) to the distal right bundle branch or apical region of RV. This pathway usually represents a duplication of the AV node and distal conducting system. It typically oc-
occupies the right ventricular free wall. Proximal part of this pathway exhibits slow conduction like AV node. Retrograde conduction is, therefore, absent and only antidromic AV reentry tachycardia can develop. Tachycardia has LBBB pattern. Development of RBBB prolongs conduction in right bundle branch and slows the rate of tachycardia. Tachycardia rate remains unaffected by aberrancy in left bundle branch.

Other electrocardiographic findings in AVRT
- If rate of tachycardia slows with appearance of functional bundle branch block, it suggests that accessory path is located in the ventricle with bundle branch block.
- QRS alternans is seen in nearly 1/3 of patients with AVRT

TACHYCARDIAS WHERE ACCESSORY PATHWAYS ALLOW FAST ANTERGRAD CONDUCTION

Atrial fibrillation
Atrial fibrillation is relatively more frequent in patients of pre-excitation than in general population. It could be initiated by a supraventricular ectopic if the retrograde conduction velocity of the accessory path is fast. In this situation, the retrogradely conducted impulse may reach atria in their vulnerable period and produce atrial fibrillation. Atrial fibrillation could also occur without involvement of accessory path. Once atrial fibrillation is established, antegrade conduction to ventricles is usually over the accessory pathway because the refractory period of the anomalous path is much short than refractory period of A-V node. Because of short refractory period the accessory path can conduct large number of atrial impulses to ventricles. Ventricular rate is, therefore, rapid. It can be in the range of 180 to 250/ minute. QRS are irregular and completely bizarre due to irregular conduction over accessory path and varying degrees of pre-excitation (Figure 10). Fast ventricular rate (above 200/ minute) in a case of atrial fibrillation should raise suspicion of conduction over accessory path. If refractory period of accessory path is very short, large number of atrial impulses may reach the ventricle. In this situation it is possible that an atrial impulse may reach the ventricles before they are fully repolarised from the effect of the preceding impulse. This situation can cause ventricular fibrillation and sudden death. Intermittent pre-excitation or sudden loss of ECG evidence of pre-excitation during exercise suggest a relatively long refractory period of accessory pathway. These patients are not susceptible to have fast ventricular rate during atrial
ECG OF THE MONTH

NARROW QRS TACHYCARDIA

Orthodromic

Long R-P

AVNRT

Atrial flutter

Narrow QRS Tachycardias
(short PR interval without delta wave in sinus rhythm)

AVN

HB

Conduction over atrio-hisian pathway

AVN

HB

Rapid conduction over A-V node

Broad QRS Regular Tachycardias

KB

AVN

BB

Orthodromic AVRT with aberrancy

Orthodromic AVRT with BBB

Antidromic AVRT involving Kent bundle

AFAP

AVN

Allerrancy

Antidromic AVRT involving atrio-fascicular accessory path

Atrial flutter 2.1 A-V conduction aberrant ventricular conduction

Atrial flutter 2.1 A-V conduction BBB

VT

Figure 13. Showing causes of narrow QRS tachycardia

Figure 14. Showing causes of broad QRS regular tachycardia
not involve the accessory path eg. atrio-ventricular nodal reentry tachycardia or ventricular tachycardia.

SUMMARY
Patients with pre-excitation can have

- Narrow QRS regular tachycardia (Figure 13):
  - Atrio-ventricular nodal reentry tachycardia (AVNRT).
  - Orthodromic atrio-ventricular reciprocating tachycardia (orthodromic AVRT) with retrograde conduction over Kent bundle. Tachycardia rate around 250/ min, electrical alternans and a p wave coming clearly after completion of QRS (in the ST segment) supports this possibility.
  - Long R-P tachycardia.
  - Atrial flutter with regular 2:1 conduction over AV node.
  - Supraventricular tachycardias in patients with short P-R interval but a normal QRS (no delta wave) in sinus rhythm.
    - Rapid conduction through the A-V node.
- Broad QRS regular tachycardia (Figure 14):
  - Orthodromic AVRT with BBB or aberrant ventricular conduction.
  - Antidromic AVRT involving a Kent bundle.
    - LBBB pattern in right sided bypass tract.
    - RBBB pattern in left sided bypass tract.
conduction over A-V node. QRS is usually, narrow but can be broad if there is aberrant ventricular conduction or BBB.

- Rate more than 200/ min
- Atrial fibrillation with antegrade conduction over accessory pathway. QRS is broad due to presence of delta wave.
- Atrial fibrillation with rapid conduction over A-V node. QRS is narrow unless there is aberrant ventricular conduction.

When ventricular rate is more than 200 per minute, it may be difficult to differentiate antegrade conduction over accessory pathway from rapid conduction over A-V node with aberrant ventricular conduction. In such cases electric cardioversion is safe. If drugs are to be used, A-V node blocking drugs (digoxin, diltiazem, verapamil, beta blockers) should be used only in combination with drugs blocking the accessory pathway (eg. amiodarone). Isolated use of A-V node blocking drugs may increase antegrade conduction over kent bundle resulting in further increase in ventricular rate. In such a situation some atrial impulse may reach ventricle in vulnerable period and precipitate ventricular fibrillation.

REFERENCES