53 Common Types of Tachycardia

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53.1 Section 1: Tachycardia with Narrow QRS Complex

Tachycardia with narrow QRS complex have a QRS interval less than or equal to 120 ms, and a frequency greater than or equal to 100 bpm. 95% of the cases are supraventricular tachycardia, which originates from above the division of the bundle branches; 5% are ventricular tachycardia, particularly idiopathic ventricular tachycardia in children which can have a QRS interval less than 120 ms. Common types of narrow QRS complex tachycardia include atrioventricular nodal reentrant tachycardia (AVNRT), atrioventricular reentrant tachycardia (AVRT) and atrial tachycardia.

53.1.1 Atrioventricular Nodal Reentrant Tachycardia

The structural basis of AVNRT is the two types of conduction pathways with different properties in the AV node, which is called dual atrioventricular nodal pathway. One of the pathways has a slow conduction rate and short refractory period, called slow pathway (α pathway). The other pathway has a fast conduction rate, but longer refractory period, and is known as fast pathway (β pathway). Normally, an excitation originating in the SA node reaches the ventricle via the fast pathway. On reaching the end of the circuit, the excitation go in retrograde via the slow pathway, offsetting the excitation that went in anterograde fashion through the same pathway (Fig. 53.1a); when atrial pacemaker discharges an impulse, as fast pathway has a longer refractory period than slow pathway, the impulse more than often pass along the slow pathway which has recovered from the refractory state, resulting in a long P′-R interval. At this time, if the excitation through the fast pathway already nears the end of the circuit and the cells in the fast pathway has recovered from the refractory state, the impulse can go in retrograde via the fast pathway back to the atria, but as the same impulse proceed again toward the ventricle, the slow pathway is still in the refractory period, stopping the impulse from passing through again. Therefore, a small pseudo r wave appears on ECG (retrograde p′ wave, Fig. 53.1b); The earlier the atria is excited, the slower the excitation pass through the slow pathway, as the impulse reaches the start of the circuit again via the fast pathway as the retrograde limb, the slow pathway has recovered from the refractory state, enabling the impulse to pass through again, forming a continuous reentrant excitation and causing what we call AVNRT (Fig. 53.1c). This is the most common mechanism of AVNRT, also known as "slow-fast" AVNRT.

There is another type of AVNRT which is more uncommon. Its fast pathway has a refractory period shorter than the slow pathway. The anterograde conduction of the reentrant excitation is through the fast pathway, and retrograde conduction via the slow pathway, forming "fast-slow" AVNRT. This type of AVNRT is very rare and makes up approximately 10% of all cases. It is more commonly seen in children. We will focus on the "slow-fast" AVNRT (Fig. 53.2) in this chapter and will not go over the details of the uncommon type (Fig. 53.3).

53.1.1.1 Slow-Fast Atrioventricular Nodal Reentrant Tachycardia

ECG Recognition (Fig. 53.2)

1. Tachycardia is usually induced by premature atrial contraction, frequency at 160–200 bpm.
2. RR interval is even, heart rhythm is regular.
3. In most cases there are no P waves because the retrograde p wave is buried in QRS complex. In a few cases there might be a retrograde p′ wave after QRS complex, some of which appear at the J point on QRS, forming a pseudo s wave in leads II, III, aVF and a pseudo r wave in lead V_1.
4. R-P′ interval < P′-R interval, R-P′ interval < 70 ms.

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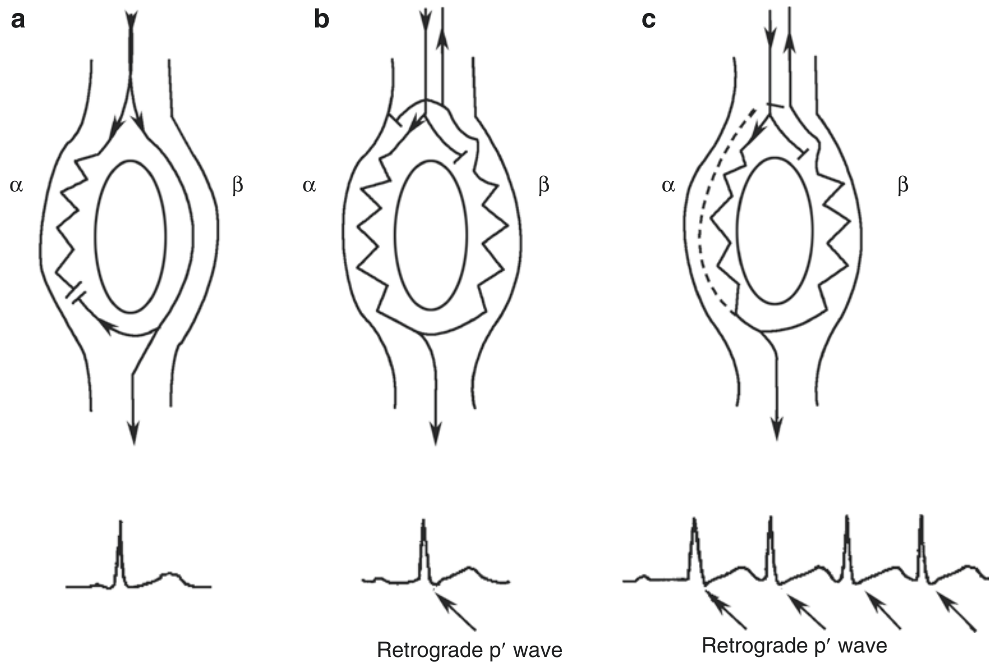


Fig. 53.1 Mechanism of slow and fast AVNRT. (**a**) An excitation originating in the SA node reaches the ventricle via the fast pathway and go in retrograde via the slow pathway; (**b**) Retrograde p′ wave appears on ECG; (**c**) How to form a continuous reentrant excitation and causing what we call AVNRT

Fig. 53.2 Slow-fast atrioventricular nodal reentrant tachycardia

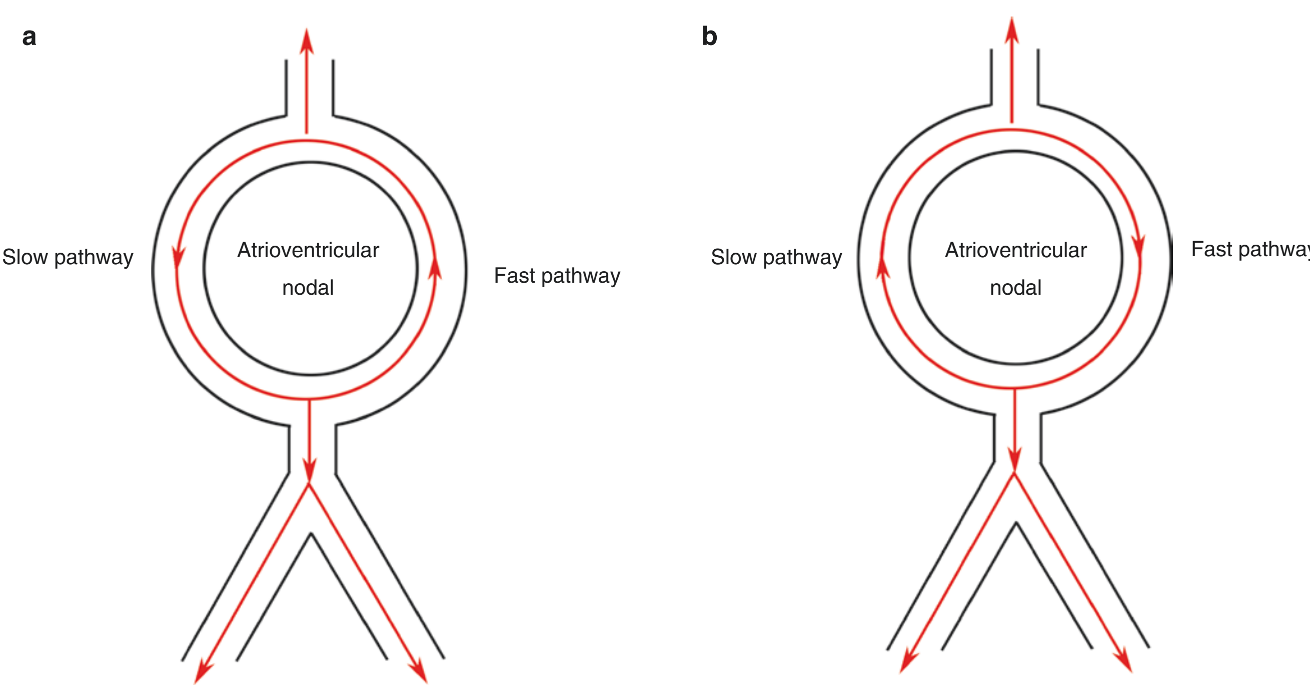


Fig. 53.3 Two types of AVNRT. (**a**) atrioventricular nodal reentrant tachycardia (common type); (**b**) atrioventricular nodal reentrant tachycardia (rare type)

5. QRS complex usually have a normal appearance. If there is aberrant ventricular conduction or existing bundle branch block, QRS complex may appear to be widened. In some patients electrical alternans in the QRS complex might be seen.

53.1.1.2 Atrioventricular Reentrant Tachycardia

Under normal circumstances, AV node-His-Purkinje system is the only conduction pathway between the atria and the ventricles. The atrioventricular ring surrounding the system are insulated, functioning as a barrier. In some patients with congenital developmental anomalies, there are additional conduction bundles (also known as accessory pathways) beside the normal conduction pathway. Excitation from the atria can reach the ventricles through the original pathway or the accessory pathway. Because of the unique electrophysiological characteristics of the accessory pathway, atrioventricular reentrant conduction is more likely to occur as the atria, the original atrioventricular conduction pathway, the ventricles as well as the accessory pathways join to form a big reentrant circuit, resulting in AVRT.

There are two types of accessory atrioventricular pathways that cause AVRT

1. **Concealed accessory pathway:** there can only be retrograde conduction through the pathway and no anterograde conduction, so during a sinus rhythm or tachycardia, impulse is conducted in the normal manner to the ventricles, and passes back through the accessory pathway. Its ECG features include a normal QRS complex with no delta wave (Refer to pre-excitation syndrome related material). This is called orthodromic AVRT.
2. **Dominant accessory pathway:** There can be both anterograde and retrograde conduction through the pathway. During a sinus rhythm, the sinus excitation can either be conducted in the normal manner down to the ventricles or pass through the accessory pathway and reach some parts of the ventricles at a faster rate, causing associated cardiac muscles cells to depolarize earlier. Its manifestation on the ECG is a delta wave before the QRS complex; When tachycardia occurs, the excitation can spread downward through the normal pathway, go in reverse through the accessory pathway, causing orthodromic AVRT, with normal QRS complex on ECG tracing without any delta wave (Fig. 53.4a);The excitation can also spread downward through the accessory pathway and pass back through the normal pathway, causing antidromic AVRT, with wide QRS complex along with delta wave on ECG tracing (Fig. 53.4b).

53.1.1.3 Orthodromic Atrioventricular Reentrant Tachycardia

ECG Recognition (Fig. 53.5)

1. Heart rate during tachycardia is 150–250 bpm, but it's usually >200 bpm.
2. Regular heart rate.
3. Under most circumstances there is no P wave because the retrograde p wave is buried in the QRS complex, but occasionally we can see a retrograde p′ wave after the QRS complex.
4. R-P′ interval < P′-R interval, R-P′ interval > 70 ms.
5. Atrioventricular conduction ratio is 1:1. There shouldn't be atrioventricular block because normal conduction

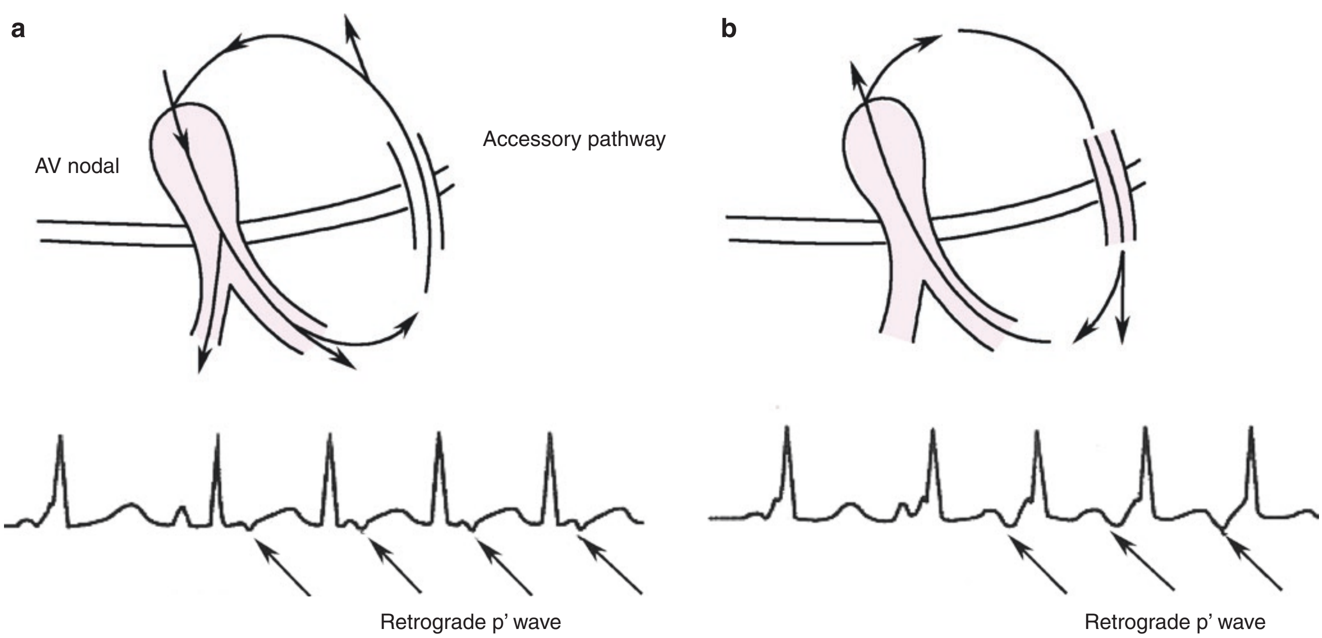


Fig. 53.4 AVRT by dominant accessory pathway. (**a**) Orthodromic AVRT with normal QRS complex without any delta wave on ECG; (**b**) Antidromic AVRT with wide QRS complex along with delta wave on ECG

Fig. 53.5 Orthodromic atrioventricular reentrant tachycardia

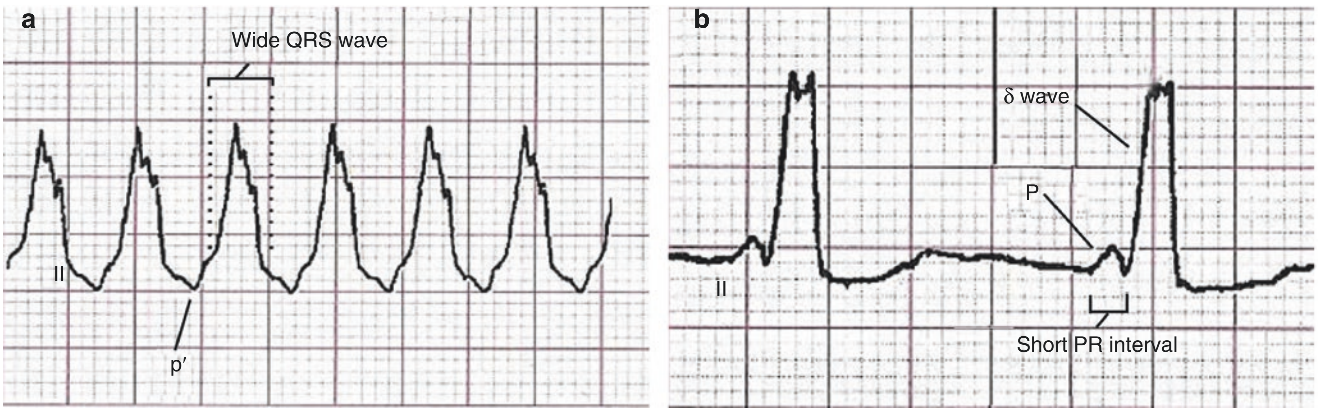


Fig. 53.6 Antidromic atrioventricular reentrant tachycardia. (**a**) During tachycardia; (**b**) during normal sinus rhythm

between the atria and the ventricles is the prerequisite for maintaining reentry. If atrioventricular block occurs, we can eliminate the possibility of AVRT.

6. QRS complex usually have a normal appearance. If there is aberrant ventricular conduction or existing bundle branch block, QRS complex may appear to be widened. In some patients electrical alternans in the QRS complex might be seen.
7. AVRT can often be induced or stopped by premature atrial or ventricular contraction.
8. Tachycardia induced by the dominant pathway can have a normal QRS complex on ECG tracing; During sinus rhythm, ECG tracing shows feature of pre-excitation syndrome.

53.1.1.4 Antidromic Atrioventricular Reentrant Tachycardia

ECG Recognition (Fig. 53.6)

1. Delta wave can be seen at the start of the QRS complex.
2. heart rate during tachycardia is between 150 and 250 bpm, usually it's >200 bpm, with a regular heart rhythm.
3. In most cases there is no P wave, if there is P′ wave, then R-P′ interval > P′-R interval.
4. During a sinus rhythm, QRS complex shows features of pre-excitation syndrome.

53.1.1.5 Atrial Tachycardia

The mechanism of atrial tachycardia is rather different than what we see on ECG, it can be categorized into three types, automatic atrial tachycardia (AT), reentrant atrial tachycardia and multifocal atrial tachycardia (MAT). Its most important characteristic is P waves with altered appearance than those from sinus origin.

ECG Recognition (Fig. 53.7)

1. Atrial rate is usually 150–200 bpm, ventricular rate is usually between 100 and 150 bpm.
2. P wave alter in appearance from those in a normal sinus rhythm(upright in leads II, III, aVF, inverted in aVR); it can also become a retrograde p′ wave(inverted in leads II, II, aVF and upright in aVR), those with uneven P′-P′ or P′-R intervals are called multifocal atrial tachycardia (MAT).
3. Often, second-degree AV block type I or type II can be seen, with a conduction ratio of 2:1, but it does not affect the state of tachycardia.
4. The isoelectric line still exist between P waves(which is distinct from atrial flutter, when the isoelectric line disappears).
5. Stimulation of the vagus nerve cannot stop tachycardia, instead it can aggravate AV block.
6. Heart rate gradually increases at the onset of atrial tachycardia.

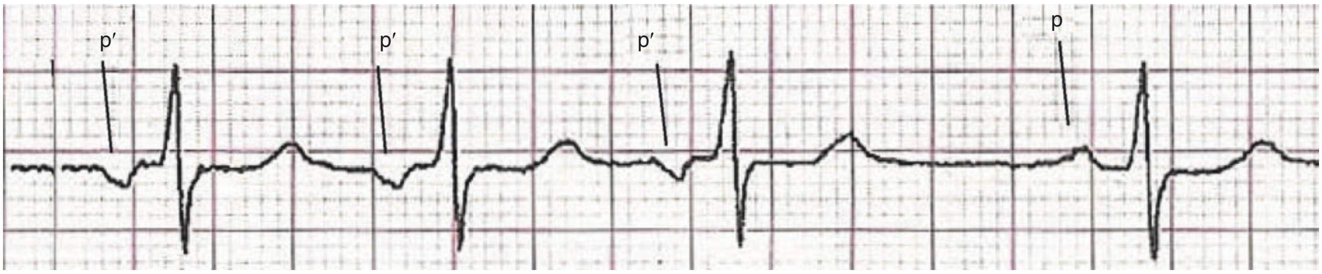
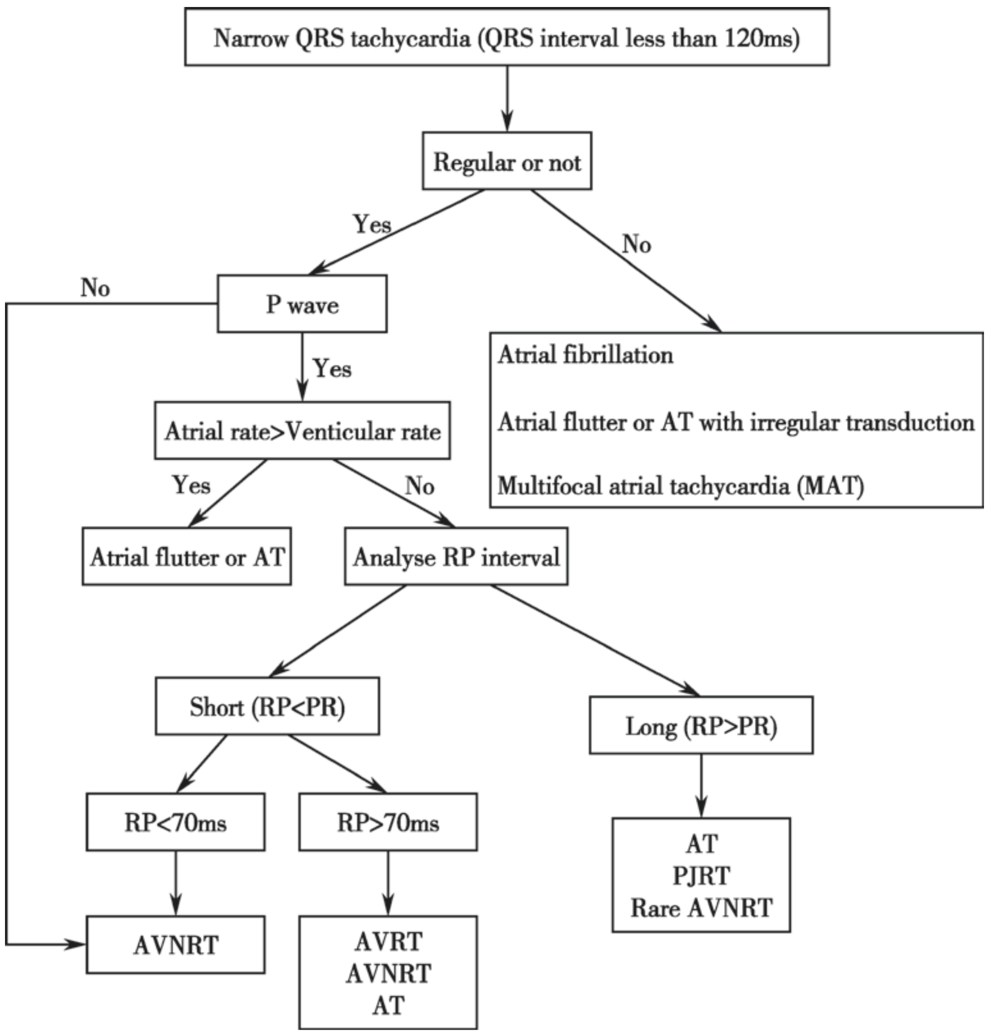


Fig. 53.7 Atrial tachycardia

Fig. 53.8 Algorithm For differential diagnosis Of QRS narrow tachycardia



Addendum: Algorithm For Differential Diagnosis Of QRS Narrow Tachycardia (Fig. 53.8)

53.2 Section 2: Tachycardia with Wide QRS Complex

Wide complex tachycardia refers to tachycardia with the duration of QRS complex ≥0.12 s and HR > 100 bpm. The following types of wide complex tachycardia are common in clinical practice:

1. Ventricular tachycardia (accounting for about 70–80% of wide complex tachycardia).
2. Supraventricular tachycardia with any of the followings:
   - With aberrant intraventricular conduction (including bundle branch blocks or other types of intraventricular blocks, accounting for 15%).

- With accessory pathway conduction (accounting for 1–5%).
- With effect of medication or electrolyte disturbances.
- With slow ventricular conduction (postoperative).

3. Ventricular pacing

Diagnosis of wide QRS complex SVT requires the ECG before the onset of tachycardia as reference, but we are not going into further details on this in this section. Here we will focus on differential diagnosis of VT versus wide complex tachycardia.

53.2.1 Ventricular Tachycardia(VT)

53.2.1.1 ECG Recognition (Fig. 53.9)

1. Continuous wide QRS complexes, duration≥0.12 s and HR > 100 bpm.
2. Frequency: usually 150–200 bpm.
3. Tachycardia can be either paroxysmal or sustained.
4. If all QRS complexes have the same morphology and amplitude, the ECG variant is defined as monomorphic VT (Fig. 53.9a); If three or more QRS complexes with distinct morphology appear in the same lead with a frequency of more than 200 bpm, and such pattern continues for ten or more heartbeats, the variant is defined as polymorphic VT (Fig. 53.9b). Polymorphic VT can be subdivided into two types: sinus rhythm with normal QT intervals; sinus rhythm with prolonged QT intervals, which is usually torsade de pointes (Fig. 53.9c).

53.2.2 Differential Diagnosis of Wide Complex Tachycardia

53.2.2.1 Ventricular Rate and Ventricular Rhythm

1. Ventricular rate: In most VT cases, ventricular rate is between 150 and 200 bpm and ventricular rate more than 180 bpm rarely happens. If this rate is too high, then it is more likely a SVT or atrial flutter with 1:1 AV conduction rather than VT.
2. Ventricular rhythm: In VT, ventricular rhythm can be either regular or a bit irregular. However, in SVT the rhythm is strictly regular.

53.2.2.2 Atrioventricular Dissociation (AV Dissociation), Ventricular Capture and Ventricular Fusion Wave

If AV dissociation is present and ventricular rate is faster than atrial rate, the diagnosis of VT can be confirmed. In addition, ventricular capture and the appearance of ventricular fusion wave are important evidence for the diagnosis of VT.

53.2.2.3 Duration of the QRS Complex

In general, the wider the QRS complex, the greater possibility of VT. A RBBB-like morphology with duration more than 0.14 s, or a LBBB-like morphology with duration more than 0.16 s is highly suggestive of VT. In a few cases, the duration of QRS complex in VT can be normal, such as in idiopathic left ventricular tachycardia (IVT).

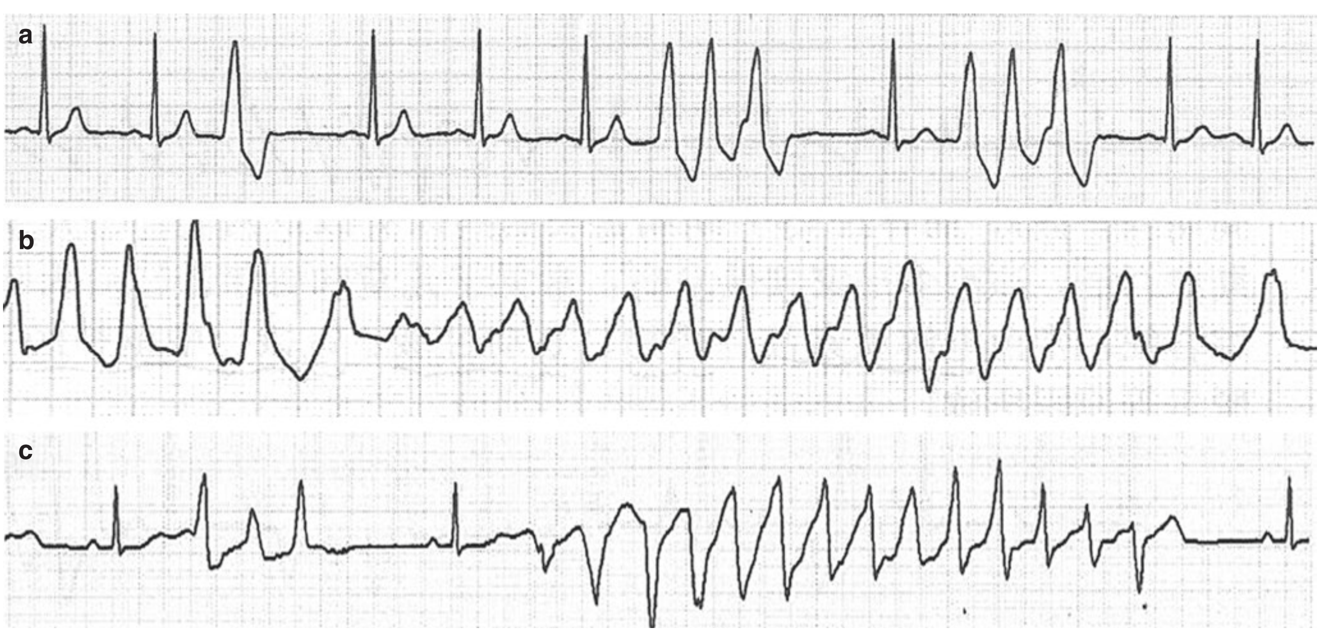


Fig. 53.9 Morphology of VT. (**a**) Monomorphic VT; (**b**) Polymorphic VT; (**c**) Torsades de pointes

53.2.2.4 Mean QRS Axis

If mean QRS axis lies between −90° and −180° (also known as extreme right axis deviation, northwest or no man's land), in most cases it's VT.

53.2.2.5 QRS Complex in Chest Leads

1. Concordant negative QRS complex pattern in chest leads indicates VT; concordant positive QRS complex pattern in chest leads, in most cases indicates VT and in a few cases is suggestive of atrioventricular reentry tachycardia (AVRT) involving a left accessory pathway.
2. When tachycardia occurs, if QR, QS or qR pattern rather than RS pattern (including RS, rS and Rs complex) is present in leads V_1 to V_6, diagnosis of VT can be clearly confirmed; If RS pattern is present in leads V_1 to V_6 with the duration of any RS waveform (the interval between the onset of R wave and the lowest point of S wave) is more than 0.1 s, VT can also be confirmed (Fig. 53.10).
3. Characteristics of QRS complex in leads V_1 and V_6: Could be divided into RBBB-like morphology (positive mean electrical axes of QRS Complexes in lead V_1, Fig. 53.11) and LBBB-like morphology (negative mean electrical axes of QRS Complexes in lead V_1, Fig. 53.12).

53.2.2.6 Others

1. A wide complex tachycardia with LBBB morphology and obvious right axis deviation indicates the diagnosis of VT. Negative mean electrical axis in leads II, III and aVF is very likely to be an indication of VT.
2. Precipitating factors of tachycardia: In most cases, tachycardia triggered by supraventricular premature contraction is SVT; Tachycardia evoked by ventricular premature contraction is usually VT.
3. Comparing ECG taken before onset of tachycardia: If the QRS complex is consistent in morphology with the complex in sinus rhythm, it usually indicates SVT, if not, then it is likely to be VT.

According to clues above to diagnosis of VT, we can summarized the ECG recognition under the condition of definitive diagnosis of VT and probable VT, and hoped it could be helpful for clinical practice:

You can make a definitive diagnosis of VT if:

- The mean electrical axes of QRS complexes in leads V_1 to V_6 are negative.
- No RS pattern is in leads V_1 to V_6.

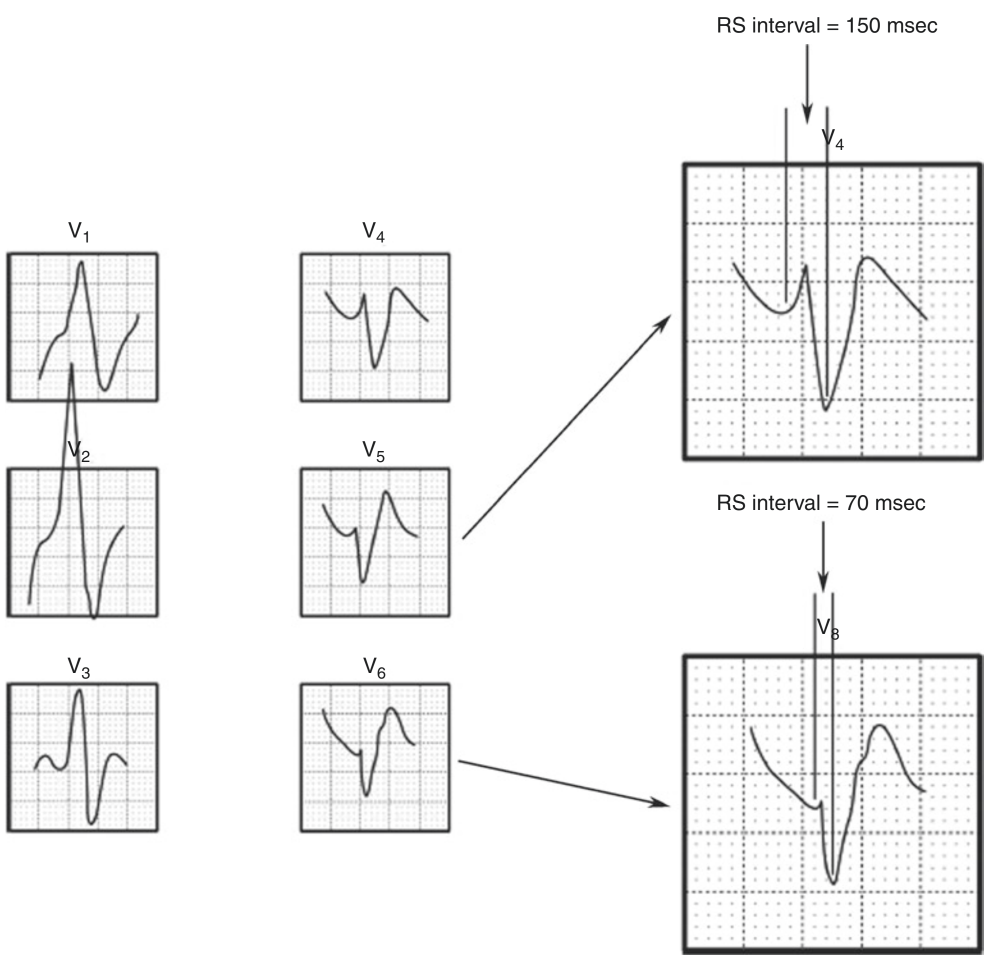


Fig. 53.10 RS pattern in leads V_1 to V_6 and measuring duration of RS complex

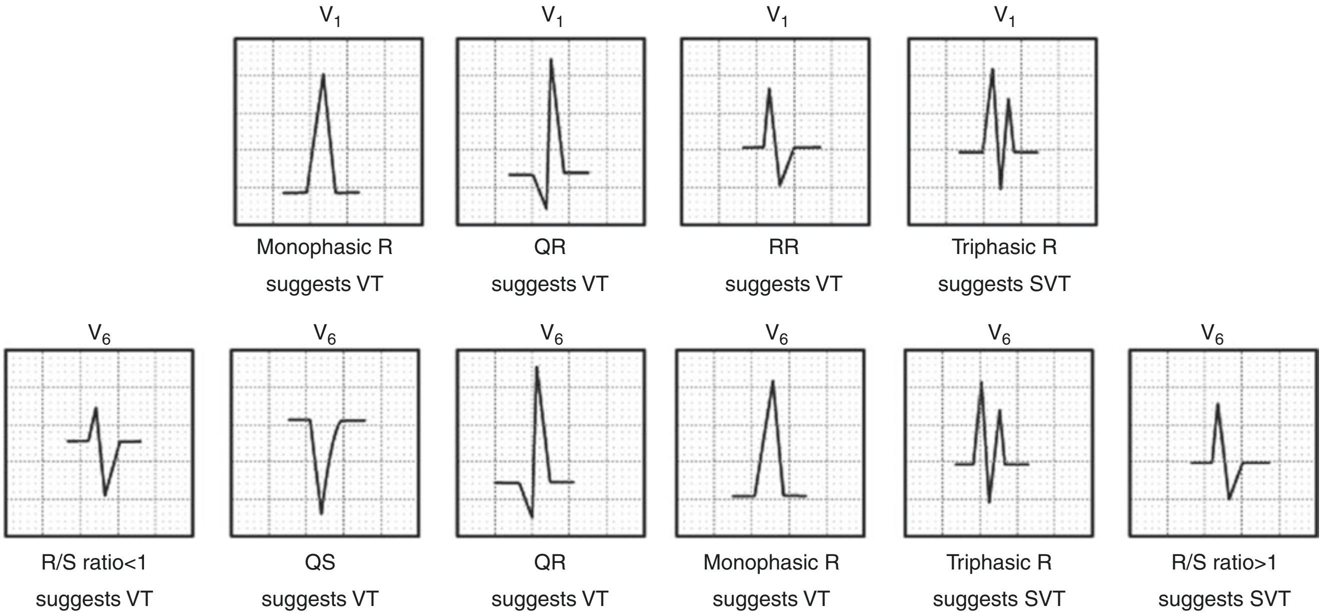


Fig. 53.11 QRS complex in RBBB-like morphology

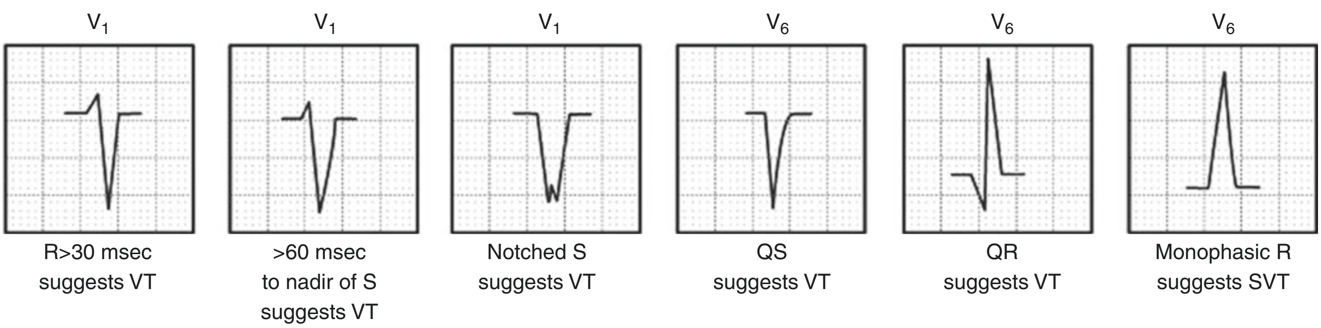


Fig. 53.12 QRS complex in LBBB-like morphology

- RS pattern is present in leads V_1 to V_6, but RS duration is more than 0.1 s.
- Evident AV dissociation with ventricular rate greater than atrial rate.
- LBBB variant with right axis deviation.
- Concordant ECG tracing with ventricular premature contraction before the onset of tachycardia.
- Presence of tall positive R wave in lead aVR.

VT highly probable if:

- All the mean electrical axes of QRS complexes in leads V_1 to V_6 are positive.
- Severe right axis deviation.
- The duration of QRS complex is more than 0.16 s in LBBB-like morphology or more than 0.14 s in RBBB-like morphology.
- All the mean electrical axes of QRS complexes in leads II, III and aVF are negative.