

## Case Discussion

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## Discussions

ECG change in hyperkalemia  
ST elevation in ECG

## Hyperkalemia

- ◆ The most serious manifestations are ascending muscle weakness or paralysis, cardiac conduction abnormalities, and cardiac arrhythmias
  - ◆ Usually occur when  $[K] \geq 7.0$  meq/L if chronic or lower if acute
- ◆ May cause metabolic acidosis by interfering with renal  $NH_4^+$  excretion

## Muscle weakness or paralysis

- ◆ Begin with the legs and progresses to the trunk and arms, and can progress to flaccid paralysis, mimicking Guillain-Barré syndrome
  - ◆ Sphincter tone and cranial nerve function are typically intact, and respiratory muscle weakness is rare
- ◆ These resolve with correction of the hyperkalemia

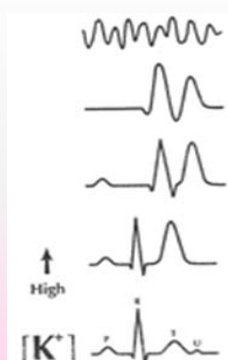
## Conduction abnormalities & arrhythmias

- ◆ Conduction abnormalities:
  - ◆ Right bundle branch block, left bundle branch block, bifascicular block, and advanced atrioventricular block
- ◆ Arrhythmias
  - ◆ Sinus bradycardia, sinus arrest, slow idioventricular rhythms, ventricular tachycardia, ventricular fibrillation, and asystole

## ECG changes

- ◆ May suggest the diagnosis before blood test results
- ◆ The progression and severity of ECG changes do not correlate well with  $[K^+]$ 
  - ◆ Normal ECG with  $[K^+] > 9.0$  meq/L is rare
- ◆ More likely with rapid onset hyperkalemia, and the presence of concomitant hypocalcemia, acidemia,  $\pm$  hyponatremia

## Serum level versus ECG change



- Higher: VF → Asystole
- > 8.0 mmol/L: Absence of widening of QRS → "sine-wave"
- 6.5 - 8.0 mmol/L: Peaked T, Prolonged PR, Decreased amplitude of P, Widening of QRS
- 5.5 - 6.5 mmol/L: Tall peaked T with narrow base
- Normal

Singapore Med J 2005; 46(8) : 430

## A tall peaked and symmetrical T



- Definition of hyperacute T
    - >5 mm in the limb leads, and usually >10 mm in the precordial leads
- Is it stand for hyperkalemia only????

### Ischemic cause

- Hyperacute phase of myocardial infarction
- Acute transient transmural ischemia (Prinzmetal's angina)
- Chronic or evolving phase of myocardial infarction (tall positive T waves reciprocal to primary deep T wave inversions)

### Nonischemic causes

- Normal variants ("early repolarization" patterns)
- Hyperkalemia
- Acute hemopericardium
- Cerebrovascular hemorrhage (more commonly T wave inversions)
- Left ventricular hypertrophy
- Right precordial leads, usually in conjunction with left precordial ST depressions and T wave inversions
- Left precordial leads, particularly in association with "diastolic" volume overload conditions
- Left bundle branch block (right precordial leads)
- Acute pericarditis (occasionally)

## Myocardial infarction?????



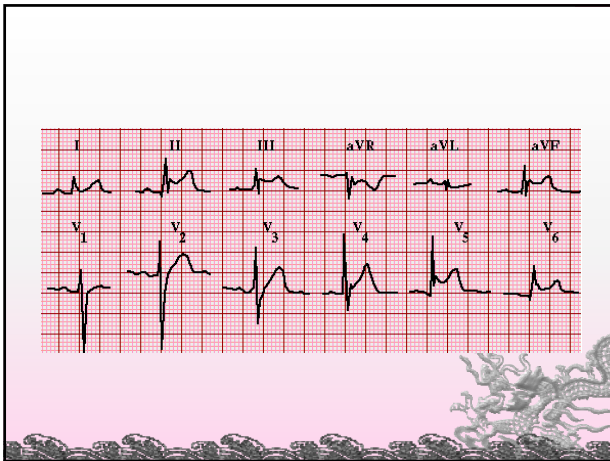
## Hyperkalemic Brugada sign

- Occurs in critically patients with significant hyperkalemia (i.e.  $[K^+] > 7.0$  meq/L)
- Pseudo-RBBB and persistent "coved" ST elevation in at least two precordial leads
- DD from genetic Brugada syndrome
  - An absence of P waves
  - Marked QRS widening
  - An abnormal QRS axis

J Electrocardiol 2007; 40:53

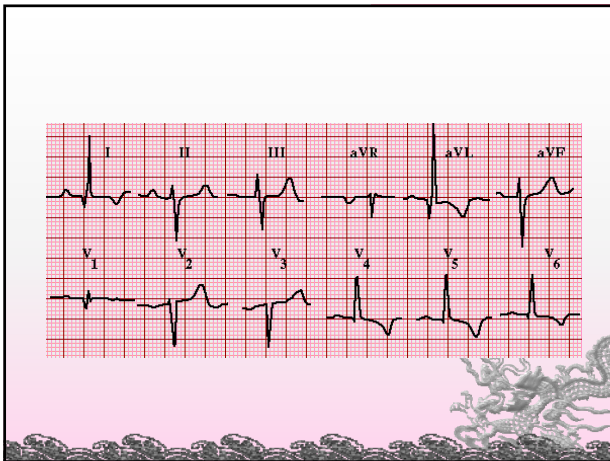
## Causes of ST segment elevation

- |                                                                                                                                           |
|-------------------------------------------------------------------------------------------------------------------------------------------|
| Myocardial ischemia or infarction                                                                                                         |
| • Noninfarction, transmural ischemia (Prinzmetal's angina pattern or acute takotsubo syndrome)                                            |
| • Acute myocardial infarction (MI) usually due to coronary atherosclerosis or occasionally to other causes (eg, acute takotsubo syndrome) |
| • Post-MI (ventricular aneurysm pattern)                                                                                                  |
| Acute pericarditis                                                                                                                        |
| Normal variants (including benign early repolarization)                                                                                   |
| Left ventricular hypertrophy or left bundle branch block (V1-V2 or V3)                                                                    |
| Others                                                                                                                                    |
| • Myocarditis (may look like MI or pericarditis)                                                                                          |
| • Massive pulmonary embolism (leads V1-V2 in occasional cases)                                                                            |
| • Brugada-type patterns (V1-V3 with right bundle branch block-appearing morphology)                                                       |
| • Myocardial tumor                                                                                                                        |
| • Myocardial trauma                                                                                                                       |
| • Hyperkalemia (only leads V1 and V2)                                                                                                     |
| • Hypothermia (J wave/Osborn wave)                                                                                                        |
| • Hypercalcemia (rarely)                                                                                                                  |
| • Post-DC cardioversion (rarely)                                                                                                          |



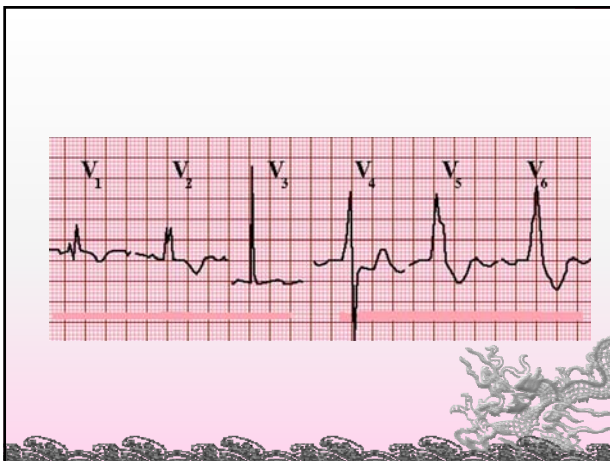
## Pericarditis

- ◆ Differential from myocardial infarction
  - ◆ Diffusely in most limb and precordial leads
  - ◆ J point elevation and concave ST elevation
  - ◆ No reciprocal changes present
  - ◆ Depression of the PR segment
  - ◆ ST returns to its isoelectric baseline and the T wave becomes inverted as pericarditis evolves



## Left ventricular hypertrophy with strain pattern

- ◆ Most often seen in the anterolateral leads (eg, I, aVL, V4-V6), but may also be seen in other leads when the hypertrophy is very severe
- ◆ Typical abnormalities include a horizontal or downsloping ST segment and T wave inversion
- ◆ Most competitive with voltage criteria and often combined with left atrial enlargement



## Intraventricular conduction delays

- ◆ The ST segments may be depressed or elevated
  - ◆ LBBB: Down-sloping ST depression and T wave inversion in leads I, aVL and V5-V6, and the ST segment is elevated and the T wave is upright in leads V1-V3 or V4
  - ◆ RBBB: ST segment depressions and T wave inversions in leads V1-V3

## Take home message

- ◆ Myocardial infarction could be atypical presentation in elderly group (eg. conscious change in our patient)
- ◆ ST segment elevation in ECG may be caused by many etiologies, including hyperkalemia, but myocardial infarction should be always considered
- ◆ ECG change may be the first clue of hyperkalemia, though it may not correlate with serum level well

## The end

Thanks for your attention!!!