

## ECG quiz: an old man with acute onset of chest pain

### 心電圖猜謎：一名出現急性胸痛的老翁

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#### Case

A 73-year-old man with history of diabetes, hypertension and hyperlipidemia, attended the emergency department for acute onset chest pain for one hour. A 12-lead electrocardiogram was obtained (Figure 1).

#### Questions

1. What are the ECG findings?
2. What is the likely culprit coronary artery?
3. What are the potential complications and implications on the prognosis?

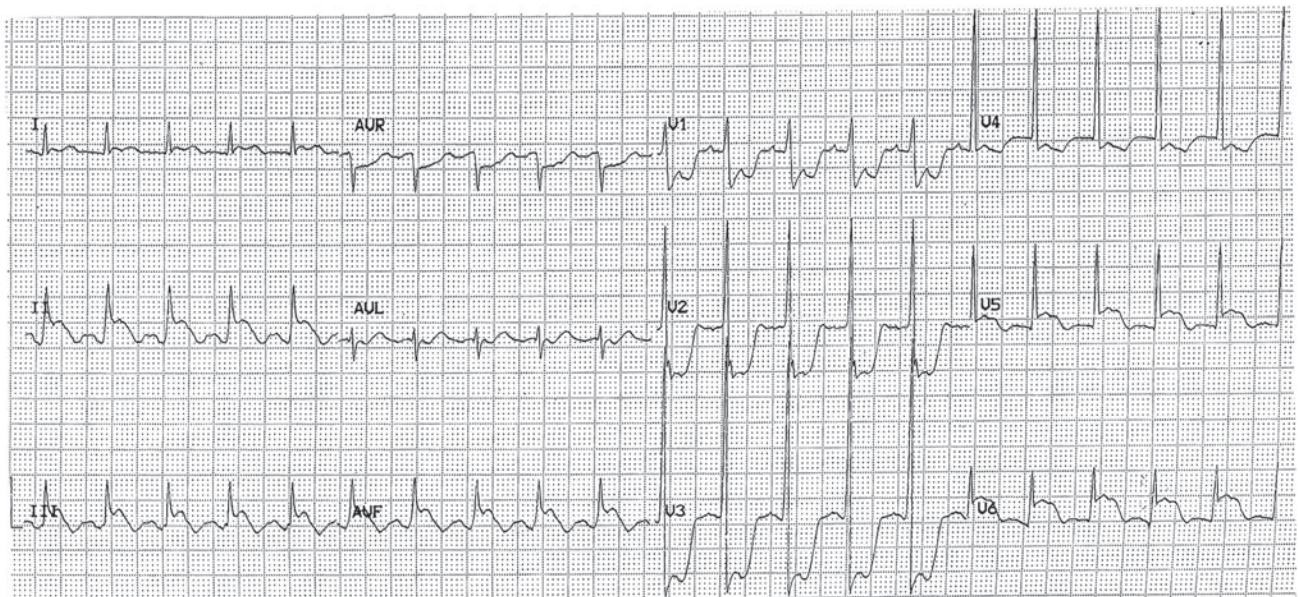


Figure 1.

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## Answers

1. The ECG showed sinus tachycardia with ST elevation over leads II, III, AVF, V<sub>5</sub>, V<sub>6</sub> and ST depression over leads AVR, V<sub>1</sub>-V<sub>4</sub>. The diagnosis was acute ST elevation myocardial infarction (MI) involving the inferolateral wall of myocardium.
2. The likely culprit was occlusion of the left circumflex coronary artery (LCX), evidenced by an ST deviation II/III ratio of more than 1, an isoelectric ST segment with absence of T wave inversion in lead I, and ST elevation over V<sub>5</sub> to V<sub>6</sub>. The ratio of ST depression in V<sub>3</sub> to ST elevation in lead III (V<sub>3</sub>/III ratio) was 2.75 which was also compatible with LCX occlusion.
3. The left circumflex artery occlusion could be associated with left ventricular dysfunction and cardiogenic shock where primary coronary intervention as reperfusion therapy should be a priority.

## Discussion

The culprit artery in acute inferior MI is usually the right coronary artery (RCA), less often the left

circumflex coronary artery, and very rarely the left anterior descending artery. The inferior myocardial wall is perfused by the posterior descending artery (posterior interventricular artery). Coronary artery dominance was defined by the origin of the posterior descending artery (PDA) and the posterolateral artery (PLA). If both PDA and PLA originate from the RCA, the coronary circulation is "right-dominant". If both originate from the LCX, it is defined as "left-dominant". If RCA supplies the PDA and LCX supplies the PLA then the circulation is defined as "co-dominant". With studies in different populations, the prevalence of right, left and co-dominant coronary circulation were 70-85%, 10% and 5-20% respectively.<sup>1,2</sup>

Studies have been carried out to differentiate the culprit arteries in acute inferior MI by electrocardiogram. The various electrocardiographic criteria for the diagnosis of LCX-related and RCA-related infarct in different studies are summarized in Table 1 and Table 2. In a recent paper Tierala et al combined various electrocardiographic features and suggested a simple sequential algorithm to predict the culprit artery in myocardial infarction which was based on ST elevation ratio of lead II/III, ST deviation of V<sub>1</sub> and V<sub>2</sub>, and ST depression in lead aVR versus aVL.<sup>3</sup>

**Table 1.** Electrocardiographic criteria for the diagnosis of left circumflex as the culprit artery in patients with acute inferior myocardial infarction

	Sensitivity	Specificity	PPV	NPV
ST deviation in leads V <sub>1</sub> ≤ V <sub>2</sub> <sup>10</sup>	44%	85%	35%	90%
ST elevation in ≥1 lateral lead(s) (aVL, V <sub>5</sub> or V <sub>6</sub> ) and isoelectric/ST elevation in lead I <sup>11</sup>	83%	96%	91%	93%
ST elevation of leads II/III ratio >1 <sup>12,13</sup>	10%	100%	100%	80%
ST elevation of leads II/III ratio =1 <sup>12,13</sup>	80%	97%	89%	95%
ST elevation of leads II/III ratio =1 and isoelectric ST segment in lead I <sup>12</sup>	75%	99%	94%	93%
ST elevation in lead V <sub>5</sub> or V <sub>6</sub> <sup>14</sup>	56%	92%	63%	89%
Ratio of ST depression in lead V <sub>3</sub> to ST elevation in lead III (V <sub>3</sub> /III ratio) >1.2 <sup>15</sup>	84%	95%	73%	98%
S/R wave ratio in lead aVL ≤1/3 + ST depression in lead aVL ≤1 mm <sup>16</sup>	88%	76%	48%	96%
No T wave inversion in lead I <sup>10</sup>	89%	71%	35%	97%
ST depression, isoelectric or elevation <0.5 mm in lead V <sub>4</sub> R <sup>10</sup>	93%	79%	45%	98%

PPV=positive predictive value; NPV=negative predictive value.

**Table 2.** Electrocardiographic criteria for the diagnosis of right coronary artery (RCA) as the culprit artery in patients with acute inferior myocardial infarction

	Sensitivity	Specificity	PPV	NPV
ST deviation in leads $V_1 > V_2$ <sup>10</sup>	85%	44%	90%	35%
ST elevation in lead III > II and ST depression in lead aVL > I <sup>17</sup>	70%	100%	100%	46%
ST elevation of leads II/III ratio <1 <sup>12,13</sup>	97%	90%	97%	90%
ST depression in lead I <sup>12,13</sup>	96%	85%	96%	85%
ST elevation of leads II/III ratio <1 and ST depression in lead I <sup>12</sup>	94%	90%	97%	82%
Ratio of ST depression in lead $V_3$ to ST elevation in lead III ( $V_3$ /III ratio) $\geq 0.5$ and $\leq 1.2$ for distal RCA occlusion <sup>15</sup>	84%	93%	91%	88%
Ratio of ST depression in lead $V_3$ to ST elevation in lead III ( $V_3$ /III ratio) <0.5 for proximal RCA occlusion <sup>15</sup>	91%	91%	88%	93%
S/R wave ratio in lead aVL >1/3 and ST depression in lead aVL >1 mm <sup>16</sup>	76%	88%	96%	89%
T wave inversion in lead I <sup>10</sup>	71%	89%	97%	35%
ST elevation $\geq 0.5$ mm in lead $V_4R$ <sup>10</sup>	79%	93%	98%	45%

PPV=positive predictive value; NPV=negative predictive value.

The most commonly quoted criteria of ST elevation ratio of lead II versus lead III base on the concept of ST segment deviation vector.<sup>4</sup> As the RCA usually perfuses the inferior and posteromedial part of the left ventricle, the vector of infarct is directed more downward than backward and more to the right than left (i.e. the vector of infarct is closer to lead III compared with lead II). As a result, the ST elevation is higher in lead III than in lead II. The LCX perfuses the posterolateral area of the left ventricle, the vector of infarct is directed more backward and to the left, and therefore the ST elevation of lead II versus III ratio is usually more than or equal to 1.

The prognosis of patients with acute inferior MI depends on the presence of right ventricular involvement which is associated with RCA occlusion.<sup>5</sup> Right ventricular infarction has higher incidences of atrioventricular block, cardiogenic shock and life-threatening ventricular arrhythmias. Moreover, it is a strong independent predictor of 30-day mortality in patients with acute MI, and therefore warrants early reperfusion therapy.<sup>6</sup> For inferior MI without right ventricular infarction, the general prognosis is better compared with anterior MI and the mortality with

thrombolytic therapy is less than 10%.<sup>7</sup> In this subset of patients, the prognosis is not necessarily better if the culprit artery is the left circumflex, especially when it is associated with left ventricular dysfunction.<sup>8</sup> Furthermore, patients with LCX-related infarct have a higher incidence of single vessel disease compared with RCA-related infarct.<sup>9</sup> Early recognition of whether the culprit artery is the LCX may facilitate the management, tailor the reperfusion therapy and perhaps, prevent potential complications.

While coronary angiogram remains the gold standard in the definition, electrocardiographic evaluation is the most readily available tool for analysis of the potential culprit artery in the acute phase of management, and perhaps can provide guidance on the timing and patient selection for primary coronary interventions.

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