

The prevalence of the male pattern in electrocardiograms of healthy Chinese adult males in Hong Kong

研究在香港健康的華裔成年男子心電圖中出現男性模式的普遍性

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Introduction: The main feature of the male pattern in electrocardiograms (ECG) is ST-elevation at the J-point of ≥ 0.1 mV in at least one of the leads V1-4 with concave upward ST-segments. The prevalence of the male pattern in ECG of healthy male foreigners who were 16-58 years old (mostly Caucasians or Blacks) was high (85%). These ST-segment elevations may meet the ECG criteria for fibrinolytic therapy according to the present guidelines for the treatment of ST-elevation myocardial infarction (STEMI), thus resulting in potentially inappropriate management. Clinicians should be aware of this common phenomenon. As yet, the prevalence of the male pattern in healthy Chinese adult males has not been studied specifically. **Materials and methods:** Standard 12-lead ECG from 202 apparently healthy Chinese adult males (aged 20-54) were collected and analysed. **Results:** The prevalence of the male pattern was 95.5% in our 202 samples ($p < 0.05$). Of these samples of male patterns, 97.4% might have met the ECG criteria for fibrinolytic therapy according to the guidelines of the American College of Cardiology and American Heart Association (2004); but if we followed the guidelines of the European Society of Cardiology (2003), only 21.8% met the criteria. **Conclusions:** The prevalence of the male pattern in ECG of healthy Chinese adult males in Hong Kong is high. Clinicians should be more cautious while managing patients with possible acute coronary syndrome to avoid over-diagnosis of STEMI. It seems the European guidelines are safer to follow as regard to the prescription of fibrinolytics for STEMI, especially for junior doctors. (*Hong Kong j.emerg.med.* 2005; 12:198-205)

引言：男性模式心電圖的主要特色是在 V1-4 導程中，至少其中一個導程在 J 點的 ST 段提升 ≥ 0.1 mV 及向上凹。16-58 歲健康的外籍男性（多為白種人或黑人）心電圖出現男性模式的普遍度很高（85%）。這種 ST 段提升可能與現時心電圖「ST 段提升心肌梗塞」處方纖維蛋白溶解治療指引中的準則吻合，因而導致可能是不適當的處理，臨床醫生應警覺這常見的現象。然而，健康的華裔成年男子心電圖出現男性模式的普遍性並未有被特別地研究過。**資料及方法：**收集及分析 202 名表面上健康華裔成年男子（20-54 歲）的標準十二導程心電圖。**結果：**在 202 個樣本中，男性模式的普遍性為 95.5% ($p < 0.05$)；而男性模式樣本中，97.4% 個案可符合 2004 年美國心臟學院及美國心臟學會訂定纖維蛋白溶解治療指引的

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心電圖準則。但若跟隨 2003 年歐洲心臟學會的指引，只有 21.8% 的個案符合準則。**總結：**香港健康的華裔成年男子心電圖出現男性模式的普遍度很高，臨床醫生應更小心處理可能有急性冠動脈綜合症的病者，以防過度診斷為 ST 段提升的心肌梗塞。特別是對年資較淺的醫生而言，似乎跟隨歐洲有關處方纖維蛋白溶解治療「ST 段提升心肌梗塞」的指引，是較為安全的方法。

Keywords: Electrocardiography, fibrinolysis, guidelines, myocardial infarction

關鍵詞：心電圖、纖維蛋白溶解、指引、心肌梗塞

Introduction

The main feature of the male pattern in electrocardiograms (ECG) is ST-elevation at the J-point of ≥ 0.1 mV in at least one of the leads V1-4 with concave upward ST-segments (Figure 1).^{1,2} Other possible features include shorter period between the J-point and the onset of the T wave, steeper slope of the ST segment (ST angle ≥ 20 degrees), steeper ascent of the T wave and higher T wave amplitude.³ ST-elevation of < 0.1

mV is designated as a female pattern.^{1,2} These characteristics make it possible to distinguish the ECG of a woman from that of a man to a certain extent.³

The prevalence of the male pattern in the ECG of healthy male foreigners between 16-58 years old (mostly Caucasians or Blacks) has been reported to be high (85%).^{1,2,4} According to a study in 1960 conducted among 6,014 healthy males in the US Air Force who were 16-58 years old, 91% had ST-elevation

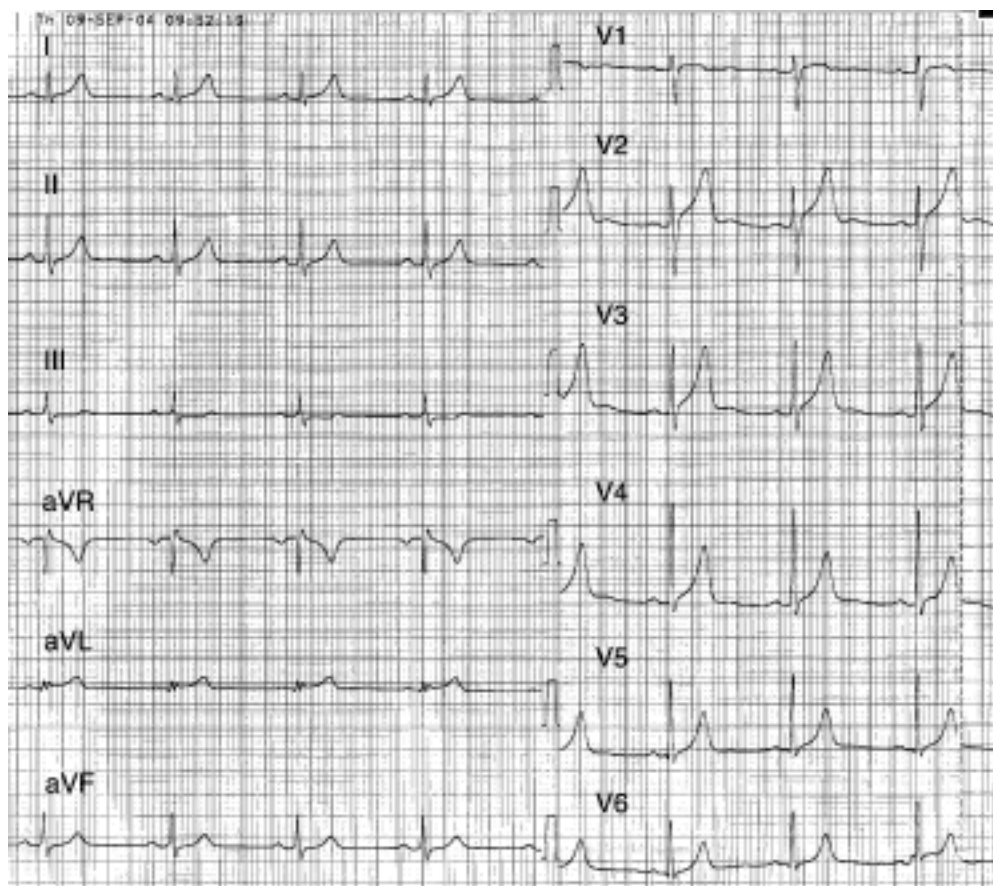


Figure 1. The male pattern electrocardiogram.

of 0.1-0.3 mV in one or more precordial leads and the elevation was most common and marked in lead V2.^{1,4} In a recent study of normal ECG from 368 males (aged 17-96), the prevalence of ST-elevation at the J-point of at least 0.1 mV in one or more of leads V1-4 was 93% in males who were 17-24 years old. The prevalence decreased gradually with increasing age, reaching 30% in the males who were 76-96 years old. The prevalence was 77% in the 212 males who were 17-54 years old.^{1,2}

As the majority of men have ST-elevation of ≥ 0.1 mV in precordial leads, it is a normal finding, and not a normal variant.¹ These ST-segment elevations are common and may have already met the ECG criteria for fibrinolytic therapy according to the present guidelines in the treatment of ST-elevation myocardial infarction (STEMI), resulting in potentially inappropriate prescription.¹ Clinicians should be aware of this common phenomenon while managing patients with possible acute coronary syndrome.

Since the prevalence of the male pattern in the ECG of healthy Chinese adult males had not been studied specifically, we undertook a study to determine the prevalence of the male pattern in the ECG of healthy Chinese adult males in Hong Kong and the prevalence of subjects with a male pattern in the ECG which also met the ECG criteria for fibrinolytic therapy according to the guidelines of the American College of Cardiology and American Heart Association (ACC/AHA) (2004)⁵ (Table 1) and the European Society of Cardiology (2003)⁶ (Table 2) respectively.

Materials and methods

Study population

The previous studies conducted by Surawicz et al² and Hiss et al⁴ revealed that the prevalence of the male pattern among males aged 16-58 ranged from 77% to 91%. So, in order to be 95% confident that the true proportion of subjects having the male pattern lain within $\pm 5\%$ of our result, we required a sample size of 196.

All subjects in our study population were ambulancemen and trainee ambulancemen in Hong Kong. They were chosen as they knew more health information, had regular physical duty and had to take annual physical fitness tests. Advertisements of our study were posted up in their training school and all the 30 ambulance depots in Hong Kong. We went to their training and working places (six depots and the training school, located on Hong Kong Island, Kowloon and the New Territories) to perform ECG for the volunteers in the mornings from 30 August 2004 to 11 September 2004.

Informed consent was obtained from each subject. All subjects were informed of the purpose of the research and their rights to participate in the study. They were reassured that their personal information would be kept confidential and their participation was on a voluntary basis.

All the ECG were recorded with the same ECG machine (Cardiovit AT-2, Schiller, Switzerland) by two members of the research team each time. They were adequately trained to place the ECG leads (Table 3),⁷ perform standard ECG and select good-quality ECG records. The ECG were recorded at a paper speed of 25 mm/s with the standardisation of 1 mm = 0.1 mV.

Table 1. ECG Criteria for ST-elevation suggestive of acute myocardial infarction, according to the guidelines of the American College of Cardiology and American Heart Association (2004)⁵

New or presumably new ST-segment elevation >0.1 mV at the point 40 ms (1 mm) past the J-point in 2 or more contiguous leads.

Table 2. ECG Criteria for ST-elevation suggestive of acute myocardial infarction, according to the guidelines of the European Society of Cardiology (2003)⁶

New or presumably new ST-segment elevation at the J-point in 2 or more contiguous leads with the cut-off points ≥ 0.2 mV in leads V1-3 and ≥ 0.1 mV in other leads.

Table 3. Placement of the precordial leads⁷

V1: in the fourth intercostal space at the right sternal border.
 V2: in the fourth intercostal space at the left sternal border.
 V3: midway between V2 and V4.
 V4: in the fifth intercostal space in the mid-clavicular line.
 V5: in the left anterior axillary line at the level of V4.
 V6: in the left mid-axillary line at the level of V4.

To be included in the study, the subjects had to fulfil all the inclusion criteria (clinical) listed in Table 4.⁸ We considered the ECG as "normal" and applicable to our study when they fulfilled all the inclusion criteria (ECG) listed in Table 5.⁸⁻¹⁰

ECG measurements

We inspected the four precordial leads V1-4. We selected two successive ECG complexes of identical QRS amplitude in each of the leads respectively and magnified them to 200% in size. We connected the onset of the 2 QRS complexes by a horizontal line (baseline).^{2,11} According to Surawicz et al, the J-point was identified as a point of sharp transition from the QRS complex to the ST-segment. We followed their guidance that if the transition was not clearly defined, we extrapolated the J-point as the point at which the ST slope extended backward began to increase (i.e. the point of "least slope") (Figure 2).^{2,12} The measurement of the J-point amplitude was from the midpoint of the tracing at the baseline to the upper border of the tracing at the J-point.^{8,13} The values of the measured amplitude was given as <1 mm, 1 mm to <2 mm, 2 mm to <3 mm, etc. We also measured the ST-segment elevation at the point 40 ms past the J-point. The pattern was considered as male when the J-point amplitude was ≥ 1 mm in at least one of the four leads V1-4 (The less strict criterion for better clinical application was adopted by Wang et al in a recent review).^{1,2}

The ECG measurements were done by two residents in Emergency Medicine (the first two authors) independently. If discrepancy was found, re-measurement would be done jointly and any difference in opinion was settled by consensus after discussion. Before reaching the consensus, the inter-observer difference of pattern definition was 1%.

Table 4. Inclusion criteria (clinical)

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- 1) Chinese adult male.
 - 2) Good past health (no known coronary heart disease nor any other type of heart disease, hypertension, diabetes mellitus, hyperlipidaemia, pulmonary disease, renal disease, thyroid disease, organic disorder of the central nervous system, psychiatric illness, active gallbladder disease, peptic ulcer disease, metabolic disease, electrolyte disturbance, anaemia, chest deformity, recent non-penetrating chest injury).⁸
 - 3) Non-smoker.
 - 4) Non-drinker or social drinker.
 - 5) Not taking any regular medication.
 - 6) Asymptomatic, especially no fever, cough, running nose, sore throat, chest discomfort, shortness of breath, palpitation nor dizziness for one week.⁸
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Table 5. Inclusion criteria (ECG)

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- 1) Sinus rhythm
 - 2) Rate 50-100 beats/min⁹
 - 3) Normal axis, between -30 degrees to +120 degrees
 - 4) P-wave <0.12 s and <0.3 mV¹⁰
 - 5) PR interval 0.12 s-0.22 s¹⁰
 - 6) QRS complex width ≤ 0.12 s
 - 7) ST-segment morphology (concave upwards)
 - 8) No large inverted T waves, most of the T waves should be upright except in leads III, aVR and V1⁸
 - 9) QTc ≤ 0.44 s
 - 10) No bundle branch block nor any probable left ventricular hypertrophy pattern (by Romhilt-Estes electrocardiographic criteria)
 - 11) No obvious ECG abnormality/gross electrocardiographic deviations⁸
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**Figure 2.** J-point identification and measurement.

Results

We performed 12-lead ECG on a total of 301 volunteers. Only 244 subjects met the clinical inclusion criteria and their ECG were further examined. A further 31 were excluded for not meeting the ECG inclusion criteria: 5 right bundle branch block, 15 probable left ventricular hypertrophy, 5 bradycardia, 1 tachycardia, 1 first degree heart block, 1 sinus block, 1 right axis deviation without other identifiable abnormality, 1 wrong leads placement and 1 incomplete ECG record. In addition, 11 samples of obvious benign early repolarisation patterns were excluded. Thus, the final study population consisted of 202 apparently healthy Chinese adult males aged 20-54. The range, mean and median of their heart rates were 50-100 beats/min, 67.7 beats/min and 68 beats/min respectively. The measured values of ST-elevation were shown in Table 6. The prevalence of the male

pattern was 95.5% (193/202) ($p < 0.05$). Table 7 shows the prevalence in four different age groups. Of the samples with the male pattern, 97.4% (188/193) showed ST-elevation of 1 mm or more at the point 40 ms past the J-point in 2 or more contiguous leads of V1-4 which might have met the ECG criteria for fibrinolytic therapy according to the guidelines of the ACC/AHA (2004)⁵ (Table 1); but if we followed the guidelines of the European Society of Cardiology (2003)⁶ (Table 2), only 21.8% (42/193) met the criteria.

Discussion

The prevalence of the male pattern in the ECG of healthy Chinese adult males in Hong Kong is high and hence ST-elevation in precordial leads can be regarded as a normal male pattern. Most of these ST-elevations

Table 6. ST amplitudes at J-point and J-point +40 ms in the precordial leads V1-4 from 202 apparently healthy Chinese adult males

	V1	V1	V2	V2	V3	V3	V4	V4
Height of ST amplitude	at J-point no. (%)	at J-point +40 ms no. (%)	at J-point no. (%)	at J-point +40 ms no. (%)	at J-point no. (%)	at J-point +40 ms no. (%)	at J-point no. (%)	at J-point +40 ms no. (%)
<1 mm	113 (55.9%)	104 (51.5%)	12 (5.9%)	5 (2.5%)	45 (22.3%)	14 (6.9%)	109 (54.0%)	56 (27.7%)
1 mm to <2 mm	86 (42.6%)	90 (44.6%)	88 (43.6%)	35 (17.3%)	116 (57.4%)	64 (31.7%)	89 (44.1%)	101 (50.0%)
2 mm to <3 mm	3 (1.5%)	7 (3.5%)	85 (42.1%)	90 (44.6%)	38 (18.8%)	90 (44.6%)	4 (2.0%)	41 (20.3%)
3 mm to <4 mm		1 (0.5%)	16 (7.9%)	57 (28.2%)	3 (1.5%)	32 (15.8%)		4 (2.0%)
4 mm to <5 mm			1 (0.5%)	14 (6.9%)		2 (1.0%)		
5 mm to <6 mm				1 (0.5%)				

Table 7. Distribution of the male ECG pattern in different age groups

Age group	Number of ECG	Male pattern number (%)
20-24	16	16 (100%)
25-35	43	43 (100%)
36-45	96	90 (93.8%)
46-54	47	44 (93.6%)
Total	202	193 (95.5%)

unfortunately might have met the ECG criteria for fibrinolytic therapy according to the guidelines of the ACC/AHA (2004)⁵: ST-elevation greater than 0.1 mV in 2 or more contiguous leads. Since this criterion can be misleading, the Clinical Policies Subcommittee of the American College of Emergency Physicians refined the guidelines by adding the qualifier ST-segment elevations that are not characteristic of early repolarisation or pericarditis, nor of a repolarisation abnormality from left ventricular hypertrophy or bundle branch block.¹⁴ Nonetheless, these guidelines still fail to address the normal ST-elevation in the right precordial leads that is present in many healthy persons.¹ Clinicians should be more cautious while managing patients with possible acute coronary syndrome to avoid overdiagnosis of STEMI.

It is probable that intravenous fibrinolytics have been prescribed to patients having a male pattern in the ECG presenting with unstable angina or "non-ST-elevation myocardial infarction" (clinically very similar to STEMI but for whom intravenous fibrinolytic therapy is not helpful or even potentially harmful).¹⁵ In the GISSI trial, the incidence of incorrect diagnoses of STEMI was 5.8%.¹⁶ In the ASSET trial, 4.1% of patients with suspected STEMI had a non-ischaemic syndrome and another 6.4% had coronary artery disease without STEMI.¹⁷ Normal ST-elevations in the male pattern mistaken as pathological ST-elevations and ST-depressions mistaken as true reciprocal changes can be causes for the confusion. It is especially problematic as percutaneous coronary intervention is usually not readily available which can be appropriate for both of these conditions.¹⁸

It is evident that strict reliance on measurable ST-segment criteria may lead to disastrous errors in the prescription of fibrinolytics.¹⁹ In clinical practice, doctors may gain additional information from the ECG to diagnose STEMI, e.g. changes in the morphology of the ST-segments, pathological Q waves, reciprocal changes in other leads, etc.²⁰ It was found that the most accurate method to diagnose STEMI is to subjectively interpret the appearance of the ST-segment plus measurable ST-segment criteria.¹⁹ Experienced doctors therefore rely more on pattern recognition rather than on an absolute measurement of the ST-segment.²⁰

However, most patients who present to hospital as an emergency are initially managed by junior medical staff. In order to maximise diagnostic accuracy and minimise delays or inappropriate management, it is very important that simple and clear instructions are given to them with regard to ST-segment measurement and interpretation.²⁰ In this respect, it seems the European guidelines are safer to follow regarding the prescription of fibrinolytics for STEMI, especially for junior doctors. Some evidence actually exists to support the use of ≥ 0.2 mV antero-septal elevation as a preferable threshold for diagnosing STEMI, because a higher proportion of patients are correctly classified as having STEMI than with a threshold of ≥ 0.1 mV in these leads (The use of ≥ 0.1 mV antero-septal elevation might result in a small improvement in sensitivity but fall in specificity).^{5,21} Besides, there is a growing concern that the interpretation of ST-elevation is not as simple as suggested by the STEMI guidelines of the ACC/AHA (2004). Fesmire recognised that there were numerous lawsuits concerning the use of the guidelines for missed diagnoses/atypical presentation of acute myocardial infarction. Plaintiffs' ECG/cardiologists can easily testify that 0.1 mV ST-elevation is present in 2 contiguous leads and thus the patient should have been treated with fibrinolytic therapy basing on the recommendations from the ACC/AHA (notwithstanding the fact that it is extremely difficult to find any ECG in a patient with chest pain who does not have 0.1 mV ST-elevation in the anterior precordial leads).²² By choosing the European guidelines with the stricter ECG criteria of ST-elevation and simpler measurement of ST-elevation over the J-point (not 40 ms after the J-point and hence decreasing the variability of the measured value), we hope it can change the hostile situation with the predictable improvement in diagnostic accuracy for STEMI.

Limitations

We initially tried to determine ST deviation by measuring the ST-segment relative to the TP baseline (the isoelectric line, from the end of the T wave to the beginning of the P wave), as recommended by the American Heart Association,²³ for the calculation of

the prevalence of subjects with a male pattern in the ECG which also meets the ECG criteria for fibrinolytic therapy according to the guidelines of the ACC/AHA (2004) (Table 1). However, we found that it was usually impractical because a line drawn from the end of the T wave to the beginning of the P wave was usually not a horizontal line. We therefore stuck to measurement of the ST-segment relative to the PR segment. Nevertheless, it has been stated that if the TP baseline is used, ST-segment measurement should be done at 60 ms or 80 ms after the J-point in order to evade the effect of atrial repolarisation. It has been recommended that the best and easiest way for determining ST deviation is to measure the ST-segment relative to the PR segment.^{1,2,11}

Because of limited resources, we have not studied the prevalence of the male pattern in the ECG of healthy Chinese females. The prevalence was about 20% in healthy female foreigners and it remained unchanged regardless of the women's age.² The difference in prevalence between males and females was found to be strongly influenced by changes in the availability or activity of the male sex hormones.^{2,24}

Ambulancemen were selected as apparently healthy adult male subjects in our study. It is important to realise that they are relatively fit and young adults, and therefore cannot completely represent the general male population in Hong Kong.

Finally, in our study, we have not included the commonly used ST-segment criteria in the local guidelines (ST-elevation ≥ 0.2 mV in 2 or more contiguous chest leads or ≥ 0.1 mV in 2 or more contiguous limb leads) because there is no specification of a point for measurement of the height of ST-segments. Besides, it has been found that the criterion of 0.2 mV is especially insensitive for STEMI manifesting in leads V5 and V6, where ST-elevation > 0.1 mV is unusual in normal individuals.^{25,26}

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