ECG Pearls for Your Practice: Interactive Discussion

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Differential Diagnosis of ST-Segment Elevation

- Hyperkalemia
- Acute pericarditis
- Ventricular aneurysm
- Acute myocardial infarction
- Prinzmetal's angina
- Left ventricular hypertrophy
- Left bundle branch block
- Brugada syndrome
- Pulmonary embolism
- Cardioversion
- Normal (male-pattern)
- Early repolarization
- ST elevation of normal variant

Suggested article: Abrahamian FM. ACS mimics: Non-AMI causes of ST-segment elevation. In: Matt A, Tabas JA, Barish RA, (eds). *Electrocardiography in Emergency Medicine*. ACEP; 2007:119-131.

Wang K, Asinger RW, Marriott HJ. ST-segment elevation in conditions other than acute myocardial infarction. *N Engl J Med*. 2003;349:2128-2135.

Hyperkalemia

- Tall, narrow-based, and pointed T-waves
  - Earliest sign
  - Symmetrical and peaked T-waves (especially precordial leads)
  - "Tenting" or "peaking" with narrow base (amplitude of T-waves: > 6 mm in limb leads or > 10 mm in precordial leads)
- QT-interval shortening
- Prolongation of PR-interval
- Flattening (low amplitude) or absence of P-wave

- Widening of QRS complex
- May also see ST-segment elevation (often downsloping) or depression
- Sine-wave
- Altered cardiac conduction (can cause any type of a block)
- Relationship between serum K^+ and ECG changes vary among different patients
- Not a reliable test for mild (5.5-6.5) hyperkalemia
- ECG changes typically start around K^+ of 6.8

Suggested article: Mattu A, Brady WJ, Robinson DA. Electrocardiographic manifestations of hyperkalemia. *Am J Emerg Med.* 2000;18:721-729.

DDx of Conditions that Can Cause Peaked T-wave

- Hyperkalemia
- Early acute MI
  - T-waves are broad rather than narrow and pointed and often associated with long QT-interval

Note: Intracranial hemorrhage can be associated with deep **inverted** T waves
  - Other associated findings are prolonged QT-interval, prominent U-wave
  - Commonly seen in precordial leads

T-wave

- Normal T-wave has an initial slow phase followed by a fast phase
- When you divide the T-wave in half, the area under the curve is **not** symmetrical
- T-wave usually is ≥10% the height of the R-wave
- Always inverted in aVR
- Always upright in leads I, II, and V4-V6
- Usually same direction as QRS complex except in right precordial leads (V1,V2)

U-wave

- Normal U-wave has an initial fast phase followed by a slow phase (opposite to T-wave)
- Upright in all leads except in aVR
- Follows T-wave axis
- Usually < 1.5 mm and is 5-25% height of the T-wave
- Largest and best seen in leads V2 and V3
- Prominent U-wave: Amplitude > 1.5 mm
- DDx of prominent U-wave: Hypokalemia, hypothermia, bradyarrhythmias, intracranial hemorrhage

Pericarditis

- Stages:
  - Stage 1: PR-segment depression
    Best seen in lead I
    Precedes ST-segment elevation

    Widespread ST-segment elevation (seldom exceeds 5mm)
    Concave upward
    No reciprocal depression

    Reverse findings in lead aVR: PR-segment elevation and ST-segment depression
  - Stage 2: PR-segment and ST-segment returns to baseline
    T-wave amplitude begins to decrease
  - Stage 3: Inverted T-waves
  - Stage 4: Normal ECG
- Use TP-segment as your baseline
- Look at lead aVL:
  - The ST-segment elevation in patients with infarction behaves reciprocally between leads III and aVL
  - The ST-segment in patients with acute pericarditis does not result in ST-depression in aVL
- Look at V6 to differentiate acute pericarditis from early repolarization:
  - Acute pericarditis: Ratio of ST-segment (mm) to T-wave amplitude (mm) ≥ 0.25
  - Early repolarization: Ratio of ST-segment (mm) to T-wave amplitude (mm) < 0.25
- DDx of PR-segment depression: Acute pericarditis, atrial infarction, and early repolarization, pericardial effusion/cardiac tamponade

Suggested article: Lange RA, Hillis LD. Acute pericarditis. *N Engl J Med.* 2004;351:2195-2202.

Ventricular Aneurysm (Dyskinetic Ventricular Segment)

- More common in men (men: female ration of 4:1)
- Commonly seen with transmural myocardial infarction
- 80% are located anterolaterally and are associated with total occlusion of left anterior descending artery
- Inferior/posterior aneurysms are less common
- Other causes of left ventricular aneurysm are blunt chest trauma, Chagas disease, sarcoidosis
- Amount of ST-segment does not correlate with the size of left ventricular aneurysm
- QRS duration increase with the age of the aneurysm

- Characteristic features on ECG:
  - Old infarction (large Q-waves) with persistent ST-segment elevation
  - ST-segment elevation with varying morphologies; commonly concave. **If non-concave, suspect myocardial infarction.**
  - ST-segment elevation is often < 3 mm and usually does not extent into lead V5
  - No reciprocal changes
  - Q waves in the same distribution of ST-segment elevation
    - Q waves can appear as early as 2 hours after myocardial infarction
    - Remember the rule of 80:20: In 80% of cases Q waves appear within 8 hours and in 20% of cases Q waves appear within 2 hours
  - Loss or poor R-wave progression
  - No change with serial ECGs or intervention (no dynamic changes)

- Diagnose: Echocardiography (sensitivity 93%; specificity 94%)
  Cardiac catheterization (gold standard)

Suggested article: Engel J, Brady WJ, Mattu A, et al. Electrocardiographic ST-segment elevation: Left ventricular aneurysm. *Am J Emerg Med.* 2002;20:238-242.

Acute Myocardial Infarction (AMI)

- ST-segment with a plateau or convex shape
- A concave shaped ST-segment elevation does not rule out AMI

- Look for reciprocal behavior (especially between leads aVL and III)
- Reciprocal changes can be absent in ~20% of the time

- Q-waves can develop as early as 2-4 hours
- Most develop within 8 hours

- With inferior wall MI, look for right ventricular infarction
  - Clues: Look for ST-segment elevation in V4R and V1
  - ST-segment elevation of > 1 mm in lead V4R with an upright T-wave in the same lead is the most sensitive electrocardiographic sign of right ventricular infarction

ECG Manifestations of AMI with Corresponding Reciprocal Changes

Location	ST segment elevation	Reciprocal changes (ST-segment depression)
Inferior	II, III, aVF	I, aVL or V1-V2
Anteroseptal	V1-V4	II, III, aVF
Lateral	V5,V6, I, aVL	V1,V2
Right ventricle	V4R	
Posterior	V8,V9	V1,V2

Prinzmetal's Angina

- The ECG manifestations of Prinzmetal's angina and AMI are indistinguishable
  - With Prinzmetal's angina, the ST-segment elevation is transient
  - Prolonged spasm can cause infarction

Left Ventricular Hypertrophy (LVH)

- One of the conditions frequently mistaken for acute infarction
- ST-segment:
  - Seen in precordial leads V1-V3 (often < 2 mm)
  - Concave shaped
  - The deeper the S-wave, the greater the ST-segment elevation
- Various voltage and non-voltage related ECG criteria exist for LVH with variable sensitivities (voltage criteria only 30% sensitive)
- Scoring system (e.g., Romhilt and Estes criteria) combining voltage and non-voltage related ECG findings associated with LVH increase sensitivity

Voltage Criteria for LVH:

- Cornell criteria (most accurate):
  - R-wave in aVL + S-wave in V3
    - > 28 mm in males
    - > 20 mm in females

Examples of Other Voltage Criteria for LVH:

- Precordial leads:
  - R-wave in V5 or V6 + S-wave in V1
    - ≥35 mm if age ≥20 years
    - ≥45 mm if age < 20 years or with left bundle branch block
- Limb leads:
  - R-wave in aVL ≥12 mm (a highly specific finding)

Non-voltage Related Findings Associated with LVH:

- ST-segment and T-wave changes (secondary ST-T changes) also known as "strain pattern"
  - ST-segment and T-wave deviation opposite in direction to the major deflection of QRS
  - ST-depression with T-wave inversion in leads I, aVL, V5, V6
  - ST-segment often downsloping (hockey stick shape)
    - Consider ischemic process if associated with horizontal ST-segment depression
  - T-waves are asymmetrical (slow downward phase with fast upward wave) and **not** deep
    - Consider ischemic process if associated with deep symmetrical inverted T-waves
  - Classic ST-T changes are usually found in patients with fully developed LVH

- Left atrial enlargement
- Left axis deviation
- Widened QRS complex
- Delayed intrinsicoid deflection (> 0.04 seconds) in left chest leads (but remains normal in right chest leads)

Left Bundle Branch Block (LBBB)

- The abnormal ventricular depolarization as well as secondary ST-T changes makes the diagnosis of concomitant AMI in the presence of LBBB difficult

- Normally, in LBBB the ST-segment and the T wave act in a discordant fashion with the main QRS complex
  - If the main QRS complex is positive (e.g., in leads I, aVL, V5, and V6), then the expected secondary ST-T changes will be ST-segment depression with T wave inversion
  - If the main QRS complex is negative (e.g., in leads V1 and V2), then the expected secondary ST-T changes will be concave ST segment elevation with upright T wave

- In LBBB, the presence of concordant changes (i.e., ST-segment elevation $\geq$1 mm in leads with a positive QRS complex such as lead V5, or ST-segment depression $\geq$1 mm in leads with a negative QRS complex such as leads V1-V3, II, III, aVF) are abnormal and considered highly specific and predictive for myocardial infarction.

  - However, the limitation of these ECG findings lies with its low sensitivity and poor negative likelihood ratio; hence, absence of these features cannot be used to exclude patients with AMI.

- Another ECG feature suggestive of AMI in the presence of LBBB is extreme (i.e., ≥5 mm) discordant ST-segment deviation. Similarly, this ECG feature also exhibits low sensitivity and may be present in the absence of acute infarction.

- Additional ECG features suggestive of myocardial infarction with LBBB may include: replacement of the secondary concave ST-segment elevations with a convex ST-segment; deep T wave inversion in leads V1 to V3; the presence of Q waves in at least two of the leads I, aVL, V5, or V6; and Q waves in II, III, and aVF especially if associated with T wave inversions.

- Clues to prior myocardial infarction may also include notching of the upstroke part of a wide S wave in at least two of the leads V3, V4, or V5 (the Cabrera sign), or notching of the R wave upstroke in leads I, aVL, V5, and V6 (the Chapman sign).

- Obtaining serial ECGs looking for dynamic changes, as well as comparison to previous ECGs are also invaluable in identifying patients with acute pathology

Suggested articles:

Sgarbossa EB, Pinski SL, Barbagelata A, et al. Electrocardiographic diagnosis of evolving acute myocardial infarction in the presence of left bundle-branch block. *N Engl J Med.* 1996;334:481-487. [Erratum in: *N Engl J Med.* 1996;334:931].

Li SF, Walden PL, Marcilla O, et al. Electrocardiographic diagnosis of myocardial infarction in patients with left bundle branch block. *Ann Emerg Med.* 2000;36:561-565.

Brugada Syndrome

- Accounts for 40%-60% of all cases of idiopathic ventricular fibrillation

- The syndrome has been linked to mutations in the cardiac sodium-channel gene

- Depression or a loss of the action-potential dome in the right ventricular epicardium

- The ST-segment elevation associated with Brugada syndrome is limited to leads V1-V2 or V3.

- Typically, it has a saddleback or coved appearance with a gradual downslope, ending with an inverted T wave

- The high take-off ST-segment in V1-V2 resembles the rSR′ pattern seen with RBBB. However the wide S wave in leads I, aVL, and V6 that are associated with RBBB may be absent in Brugada syndrome. Most often the QT interval is within normal limits and the PR interval is prolonged.

- The terminal portion of the QRS complex and the beginning of the ST-segment is indistinct. In contrast, the ST-segment associated with anteroseptal infarction complicated by RBBB has a distinct transition from the QRS complex with a horizontal or upsloping (convex), rather than downsloping, morphology.

- The ultimate diagnosis rests on exclusion of other conditions resulting in ST-segment elevation in the right precordial leads (e.g., early repolarization, LBBB, LVH, or AMI), electrophysiological studies, or with the aid of a pharmacological challenge. Arrhythmogenic right ventricular cardiomyopathy also has a similar ECG pattern to that of Brugada syndrome and the ECG distinction is difficult. A drug challenge with sodium channel blockers may help in differentiating these two conditions.

Suggested article: Antzelevitch C, Brugada P, Borggrefe M, et al. Brugada syndrome: Report of the second consensus conference. *Circulation*. 2005;111: 659-670.

Pulmonary Embolism (PE)

- Incidence and severity of the ECG pattern depends on the timing and magnitude of the obstruction in the pulmonary vasculature
- > 20 different ECG manifestations of PE have been discussed in medical literature
- ECG not useful and/or sensitive for diagnosis
- Most are nonspecific findings and often **transient**

- Sinus tachycardia is the most frequent rhythm disturbance
- Most frequent ECG pattern: Sinus tachycardia with non-specific ST segment/T wave changes

- Other findings:
  - Atrial arrhythmias (a.fib/flutter)
  - Right bundle branch block (complete or incomplete)
  - Right-axis deviation or left-axis deviation (LAD occurs more often due to preexisting disease)
  - Tall, peaked P-wave with amplitude > 2.5 mV in lead II (P-pulmonale)

  - $S_1Q_3T_3$ (not pathognomonic; not sensitive; seen in < 30%)
  - Right ventricular strain pattern (ST-segment depression with inverted T-wave in V1 and V2

- May be associated with ST-segment elevation in the inferior and to lesser degree in anteroseptal leads ("pseudoinfarct pattern")

- Inverted T-waves V1-V3 (common finding in massive PE and is the most persistent of all ECG abnormalities)

Cardioversion

- Transient ST-segment deviations, either depressions or elevations, can be encountered with transthoracic and epicardial electrical shocks

- The ST-segment elevation at times could be significant (> 5 mm), but it only lasts one to three minutes after the cardioversion

- In comparison to the patients without ST-segment elevation, patients with ST-segment elevation often have a lower conversion rate and are less likely to remain in sinus rhythm

- The mechanism of ST-segment elevation associated with cardioversion is not well understood

Normal ST-Segment Elevation

- A majority of healthy men will commonly display ST-segment elevation in the precordial leads V1-V4

- The prevalence of this so-called "male pattern" ST-segment elevation is very common and is considered to be a normal finding. It is highest in the age group of 17 to 24 years and declines gradually with advancing age.

- The amplitude of the ST-segment elevation ranges from 1-3 mm **(most marked in V2)** with a concave morphology. There are no associated T wave abnormalities or reciprocal changes.

- Similar ST-segment elevation is less frequently observed in women. If present, the ST-segment elevation in "female pattern" is most commonly < 1 mm.

Early Repolarization (Normal Variant)

- A commonly observed normal variant, often referred to as early repolarization, is also associated with ST-segment elevation in the precordial leads (most commonly involving leads V2-V5)

- The amplitude of the ST-segment elevation ranges from 1-4 mm **(most marked in V4)** with a concave morphology

    - Other associated findings include a notch at the J point and tall, upright T waves. There are no reciprocal changes.

- Less commonly, early repolarization can involve the limb leads. In this case, the associated findings include ST-segment elevation in limb leads (commonly observed in the inferior leads II, III, aVF with ST-segment elevation in lead II > lead III) and reciprocal ST-segment depression in aVR.

- Early repolarization can also involve the atrial tissue which manifests as PR segment depression. The ECG changes associated with early repolarization at times can be confused with ECG changes of stage 1 pericarditis.

ST Elevation of Normal Variant

- Midprecordial (leads V3-V5) ST-segment elevation with terminal T wave inversion can also be a normal finding. This is referred to as "ST elevation of the normal variant" and often seen in young black men.

- The morphology of the ST-segment tends to be concave. Other associated findings include short QT interval and high QRS voltage.

- Differentiating this variant from AMI may be difficult

- Helpful clues favoring myocardial ischemia may include convex ST segment elevations, a prolonged QT interval and deep, symmetrical T wave inversions

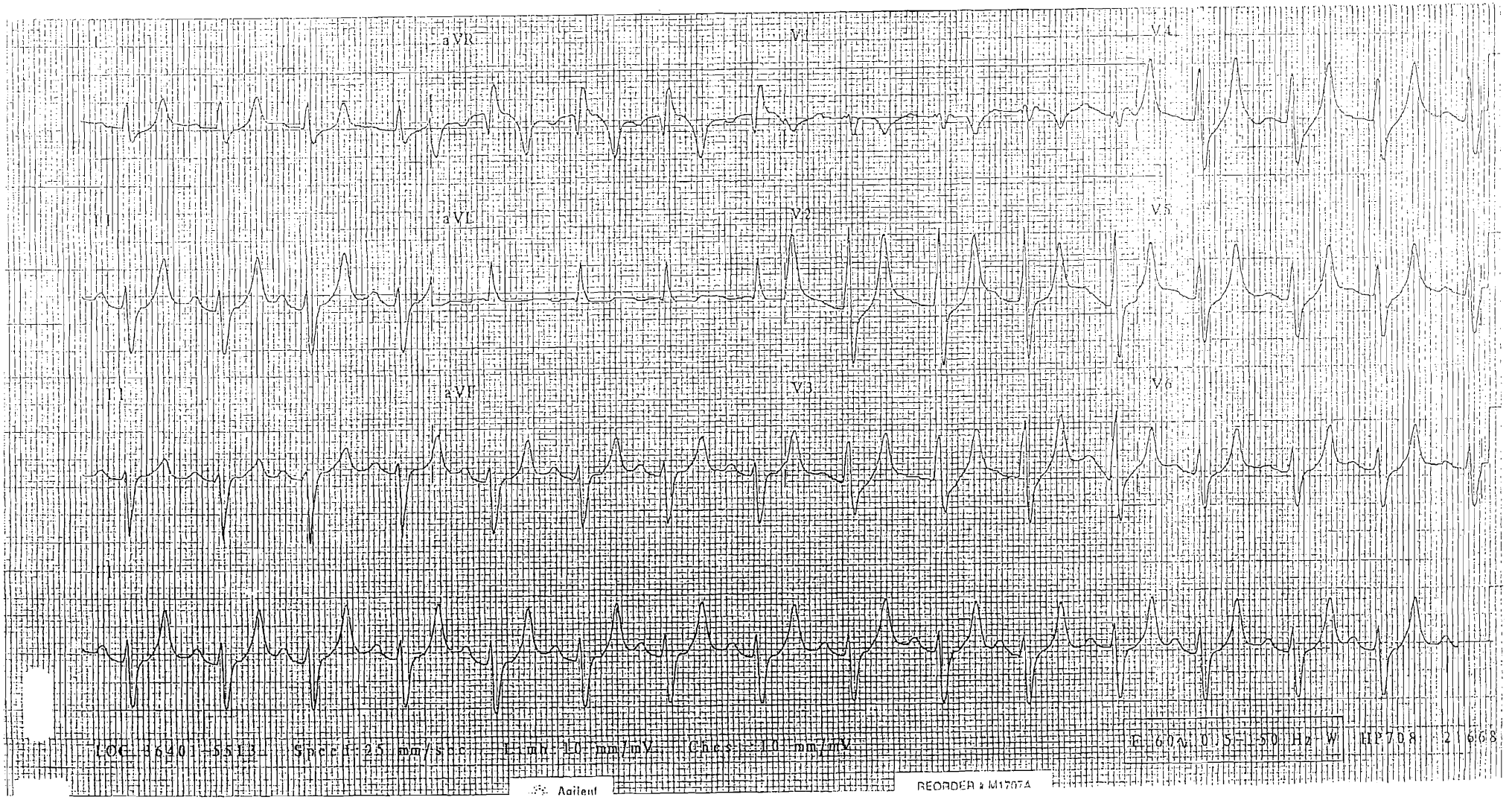
Take Home Points

- Hyperkalemic T wave: Tall with narrow base
- Hyperacute T waves: Tall with broad base
- Pericarditis: Look at lead V6 for ST-segment / T-wave amplitude ≥ 0.25
- ST elevation with infarction behaves reciprocally between leads III and aVL
- Q waves + ST elevations in V1-V4: Think left ventricular aneurysm (LVA)
- LBBB: ST-segment and T wave act in discordant fashion with the main QRS complex
- Always get serial ECGs

Rate	93	. Sinus rhythm, rate 93	.....Normal P axis, rate
PR	196	. Borderline first degree AV block	.....PR>195mS age 16-60 V-rate 91-120
QRSD	124	. Bifascicular block: RBBB & LAFB	.....RBBB with left axis deviation
QT	374		
QTc	465		

--AXIS--	
P	79
QRS	-83
T	61

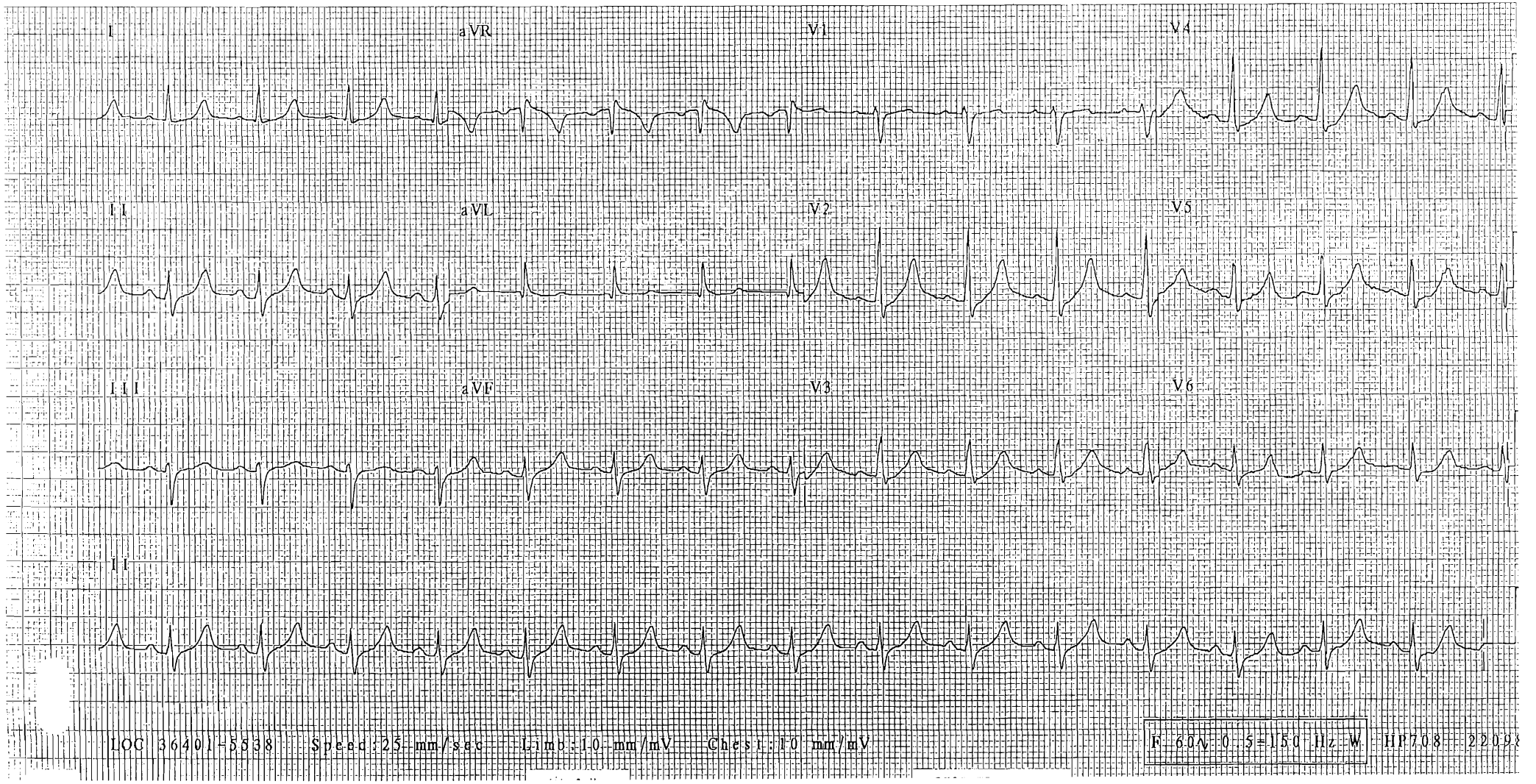
PRELIMINARY-MD MUST REVIEW



Rate	94	. Normal sinus rhythm, rate 94	Normal P axis, PR, rate & rhythm
PR	161	$ Leftward axis, probably normal for age	QRS axis -15 to -30 & age > 40
QRSD	91	. Probably normal early transition, but should	R/S > 3 and T > .30 in V2
QT	347	consider posterior infarct	
QTc	434		

--AXIS--	
P	63
QRS	-29
T	53

PRELIMINARY-MD MUST REVIEW



63 years . Male

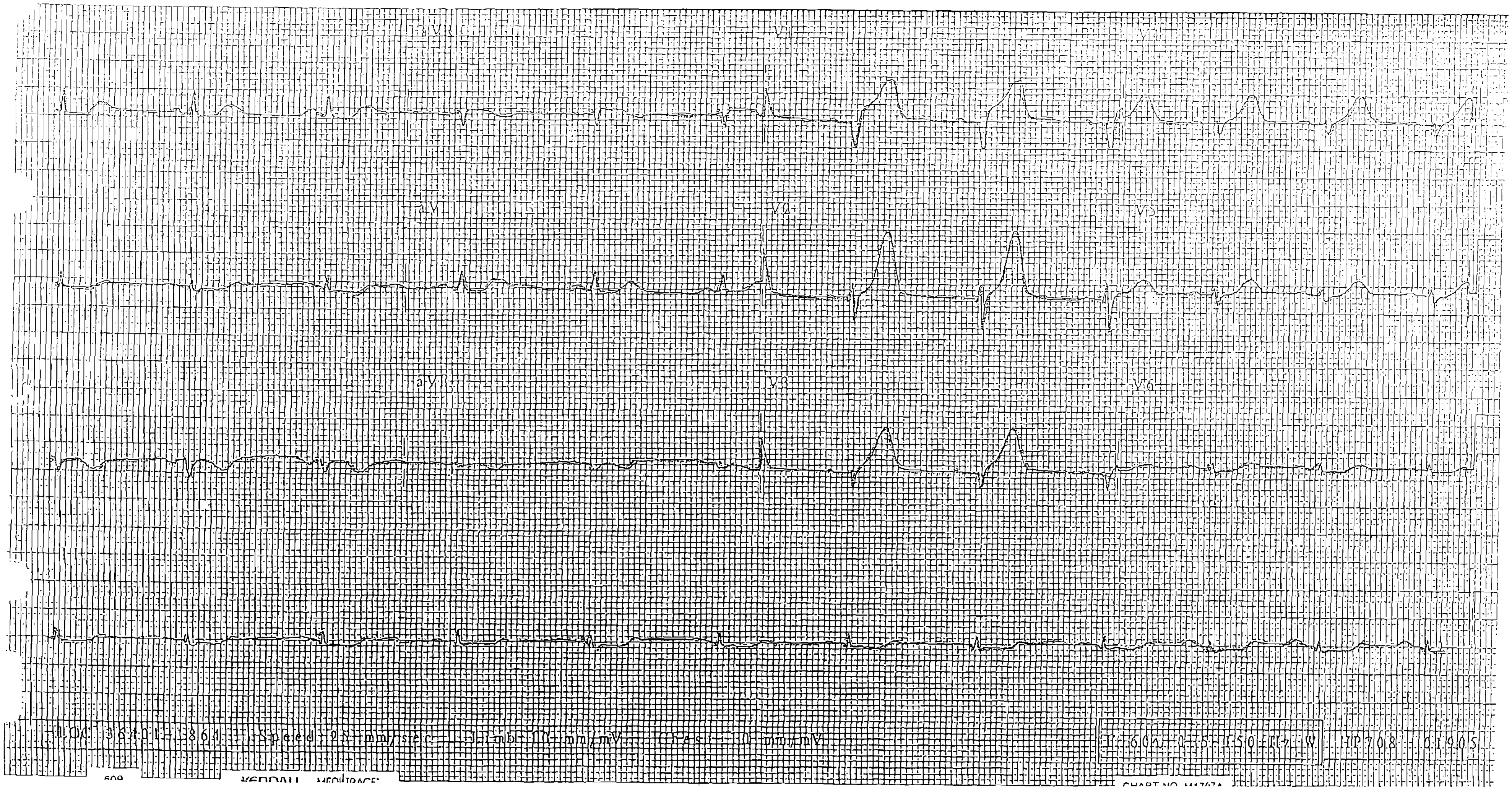
Rate	68	. Normal sinus rhythm, rate 68....................Normal P axis, PR, rate & rhythm
PR	169	. Low voltage throughout..............................Limb < 0.5 mV, chest < 1.0 mV
QRSD	64	. Inferior infarct, age indeterminate.....................Q's & neg T's II,III,aVF
QT	364	. Probable Old Anteroseptal infarct..............................Q waves in V1,V2
QTc	387	

--AXIS--

P	-17
QRS	-28
T	-42

- ABNORMAL ECG -

PRELIMINARY-MD MUST REVIEW



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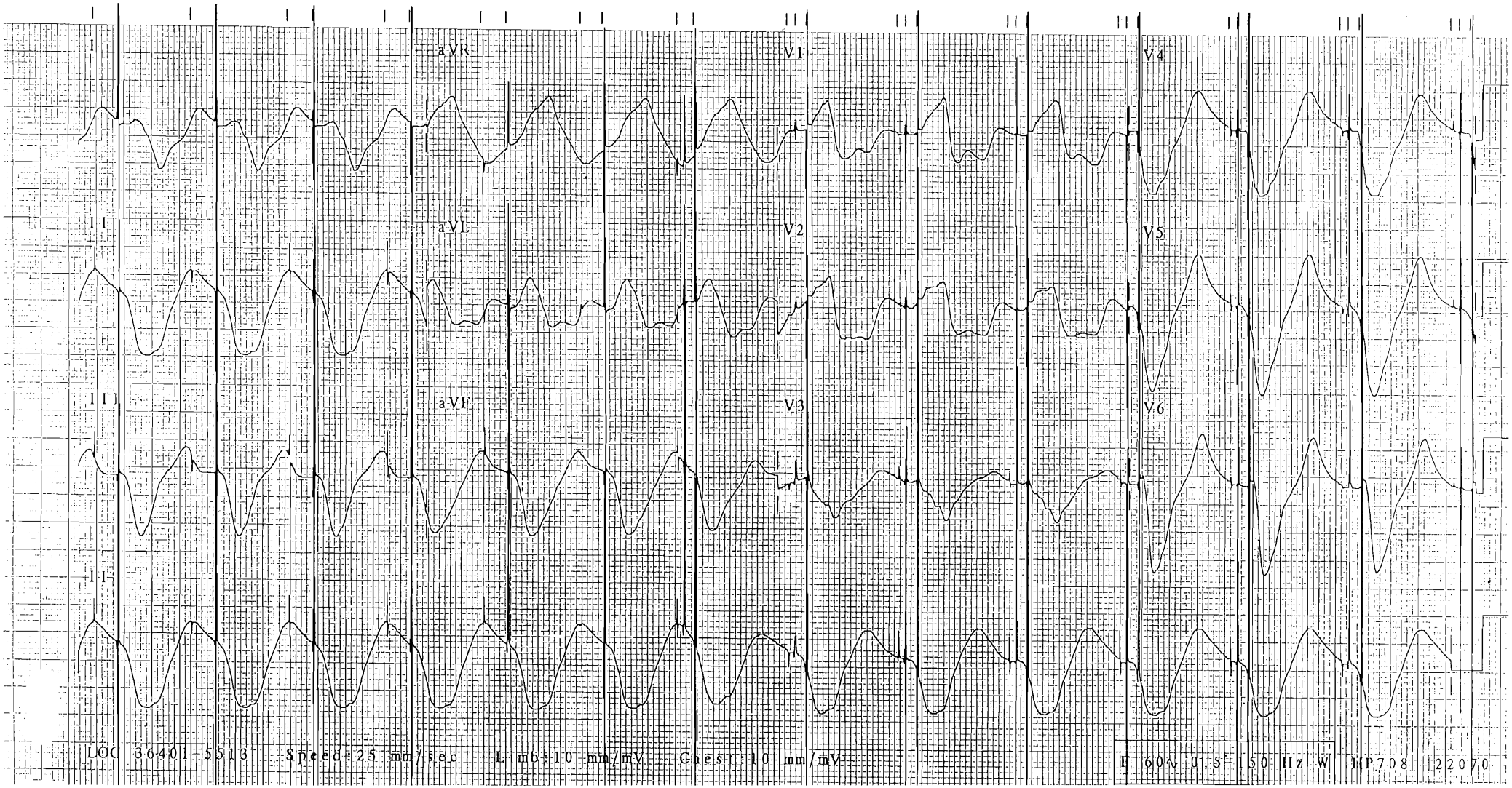
Rate	71	. Electronic pacemaker, ventricular capture. Rate = 71
PR	207	$ No further analysis attempted due to pacemaker rhythm
QRSD	97	$ Lead(s) I,II,III,aVR,aVL,aVF,V1,V4,V5 were not used for morphology analysis
QT	354	
QTc	390	

--AXIS--
P
QRS
T

PRELIMINARY-MD MUST REVIEW



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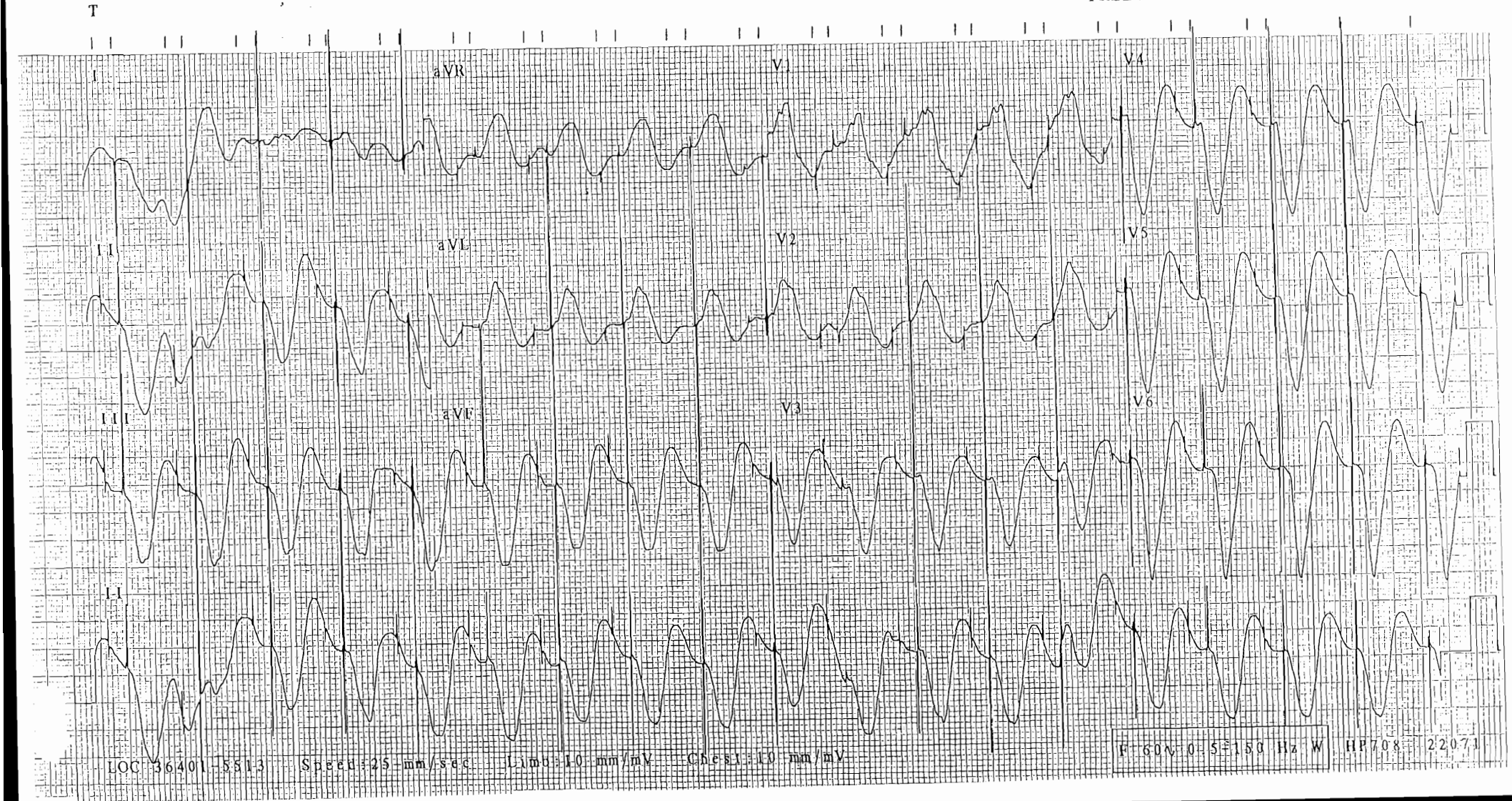
Rate 112 . Electronic pacemaker, ventricular capture. Rate = 112
PR $ No further analysis attempted due to pacemaker rhythm
QRSD $ Lead(s) I,II,III,aVR,aVF,V1,V2,V3,V4,V5,V6 were not used for morphology analysis
QT
QTc

--AXIS--
P
QRS
T

PRELIMINARY-MD MUST REVIEW



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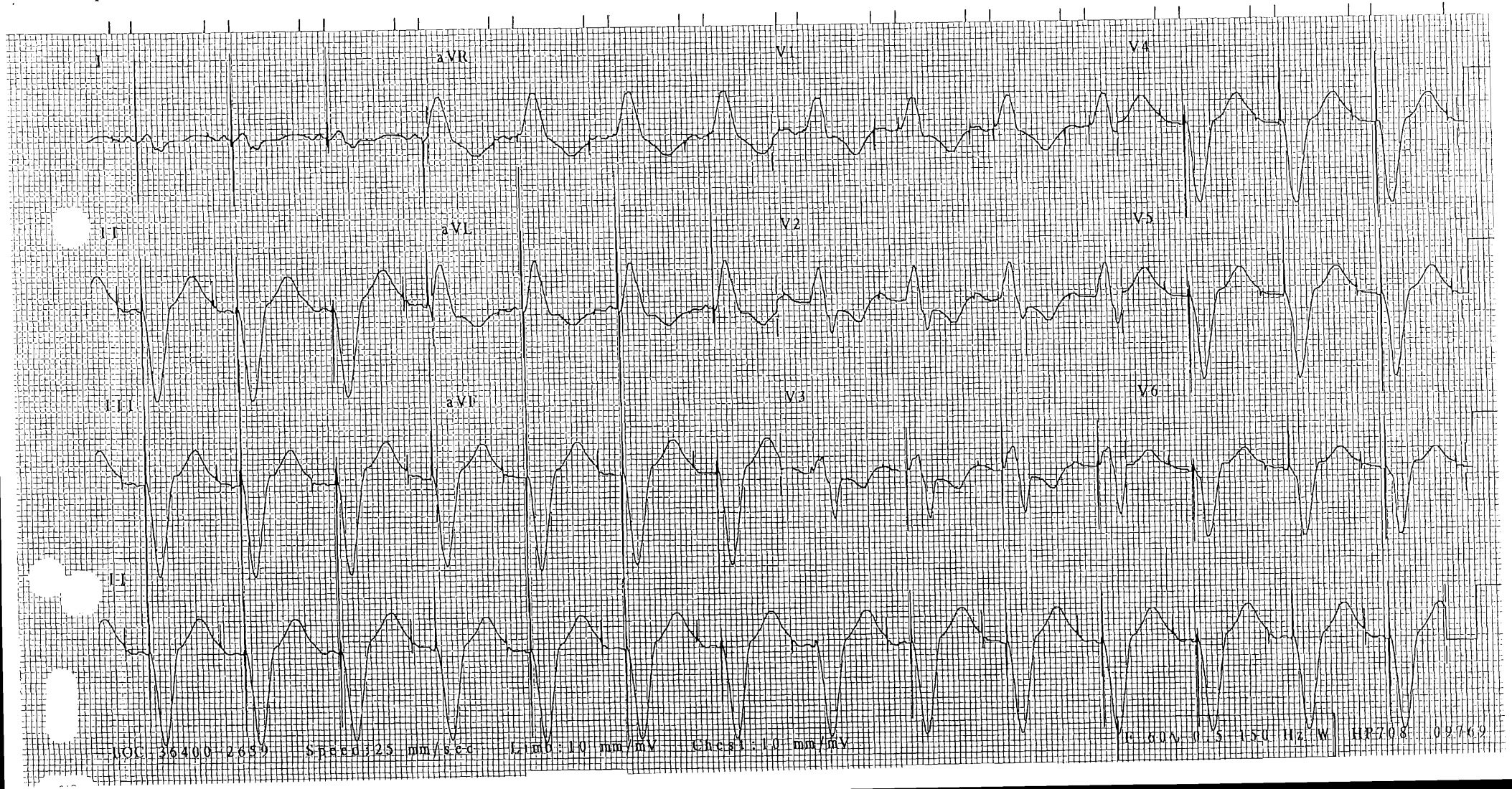
74 years Female

Rate	85
PR	200
QRSD	212
QT	334
QTc	397

--AXIS--
P
QRS
T

. Electronic pacemaker, ventricular capture. Rate = 85
$ No further analysis attempted due to pacemaker rhythm
$ Lead(s) I,II,III,aVR,aVL,aVF,V4,V5,V6 were not used for morphology analysis

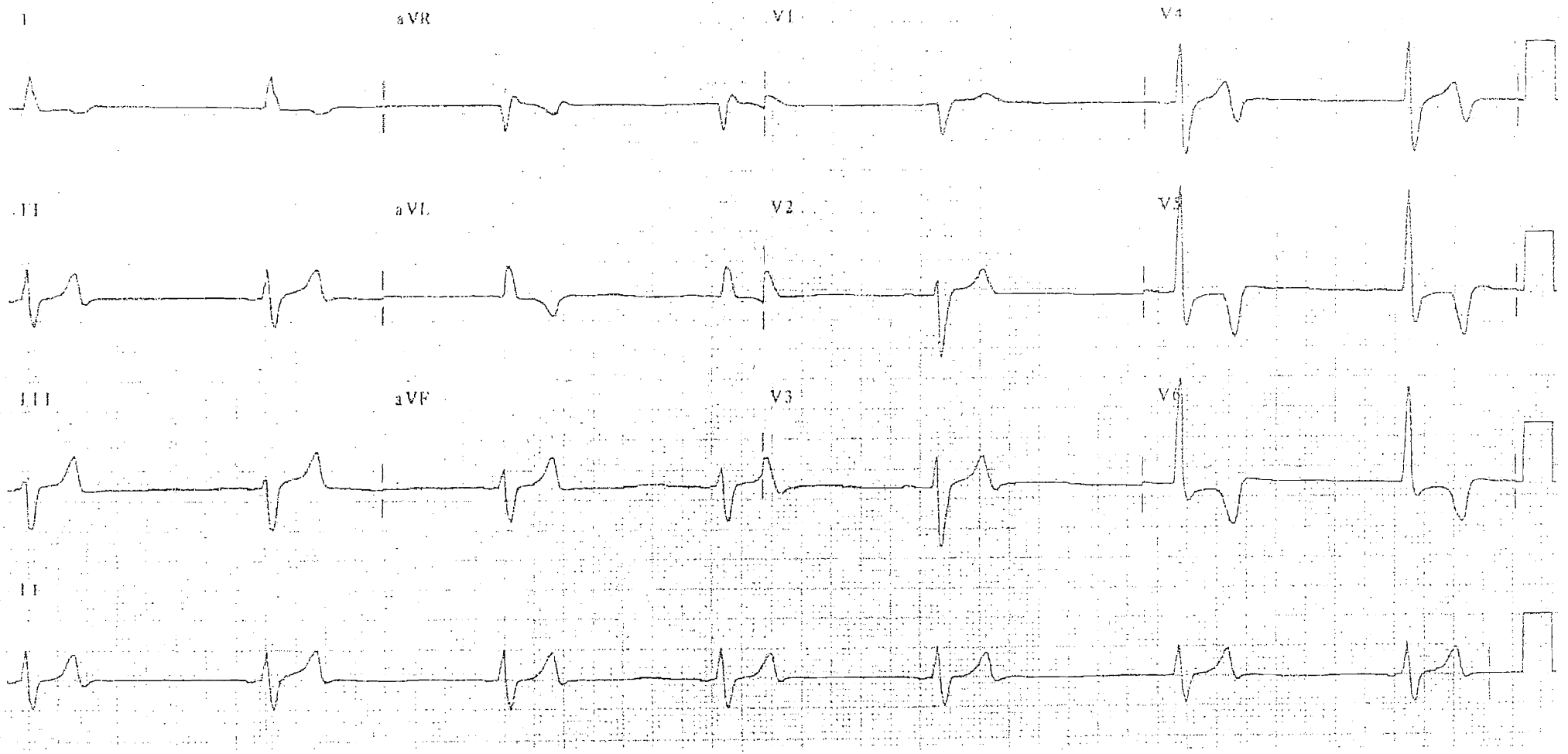
PRELIMINARY-MD MUST REVIEW



Rate	39	. 3rd degree AV block. Ventricular rate = 39.....Rate < 45 and AV dissociation
PR		. Left axis deviation.....QRS axis -31 to -90
QRSD	134	. Anterolateral ST-T abnormalities.....ST-T negative in I,aVL,V2-V6
QT	488	. . Consistent with ischemia.....T > -.60 mV, ST > -.05 mV
QTc	393	

--AXIS--	
P	
QRS	-41
T	100

- ABNORMAL ECG -

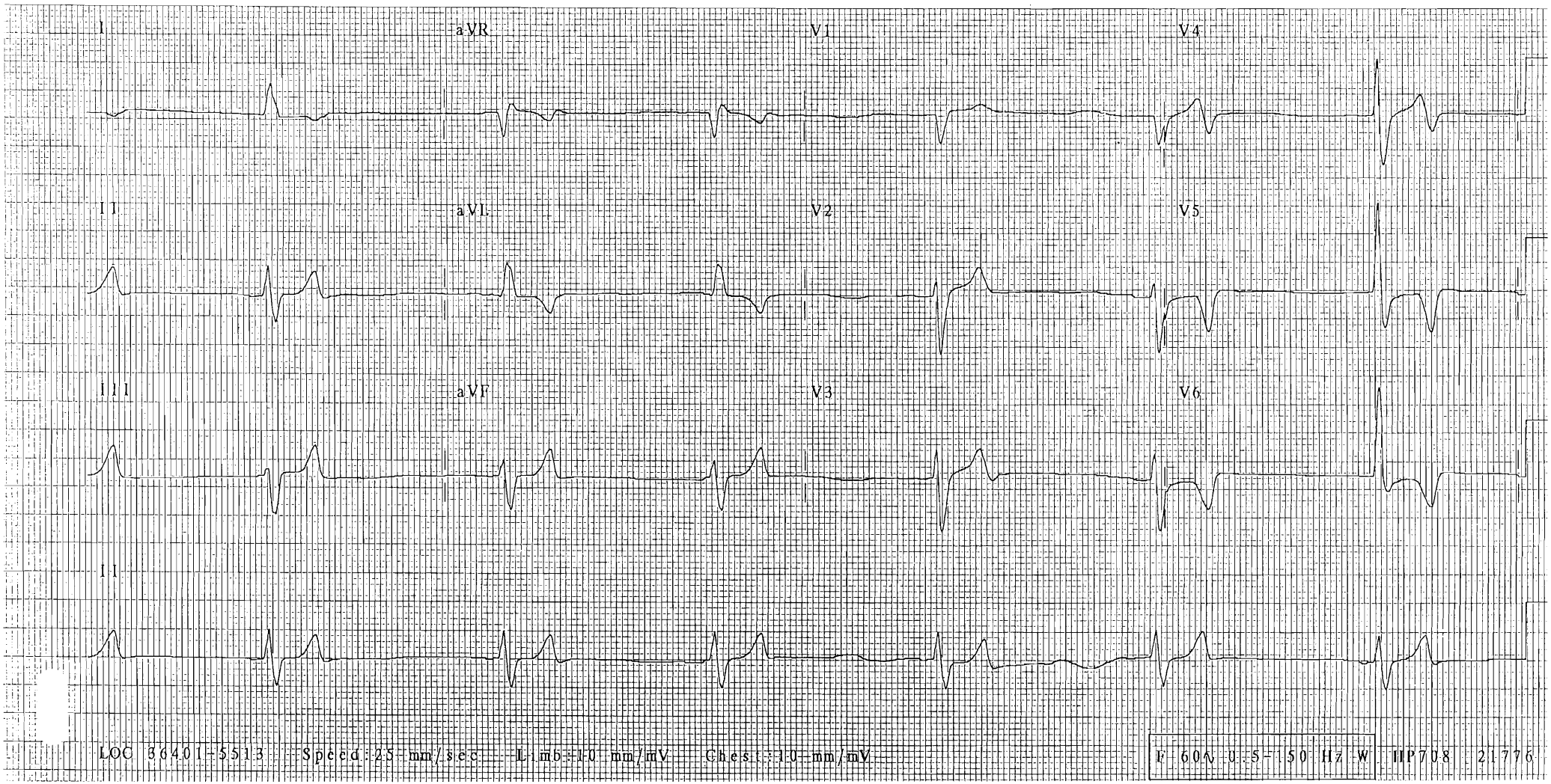


Rate	38	. Slow junctional rhythm, rate 38.....Absent P waves, rate < 40
PR		. Left bundle branch block.....QRS 120 mS, terminal forces left
QRSD	138	
QT	472	
QTc	375	

--AXIS--
P
QRS -43
T 103

- ABNORMAL ECG -

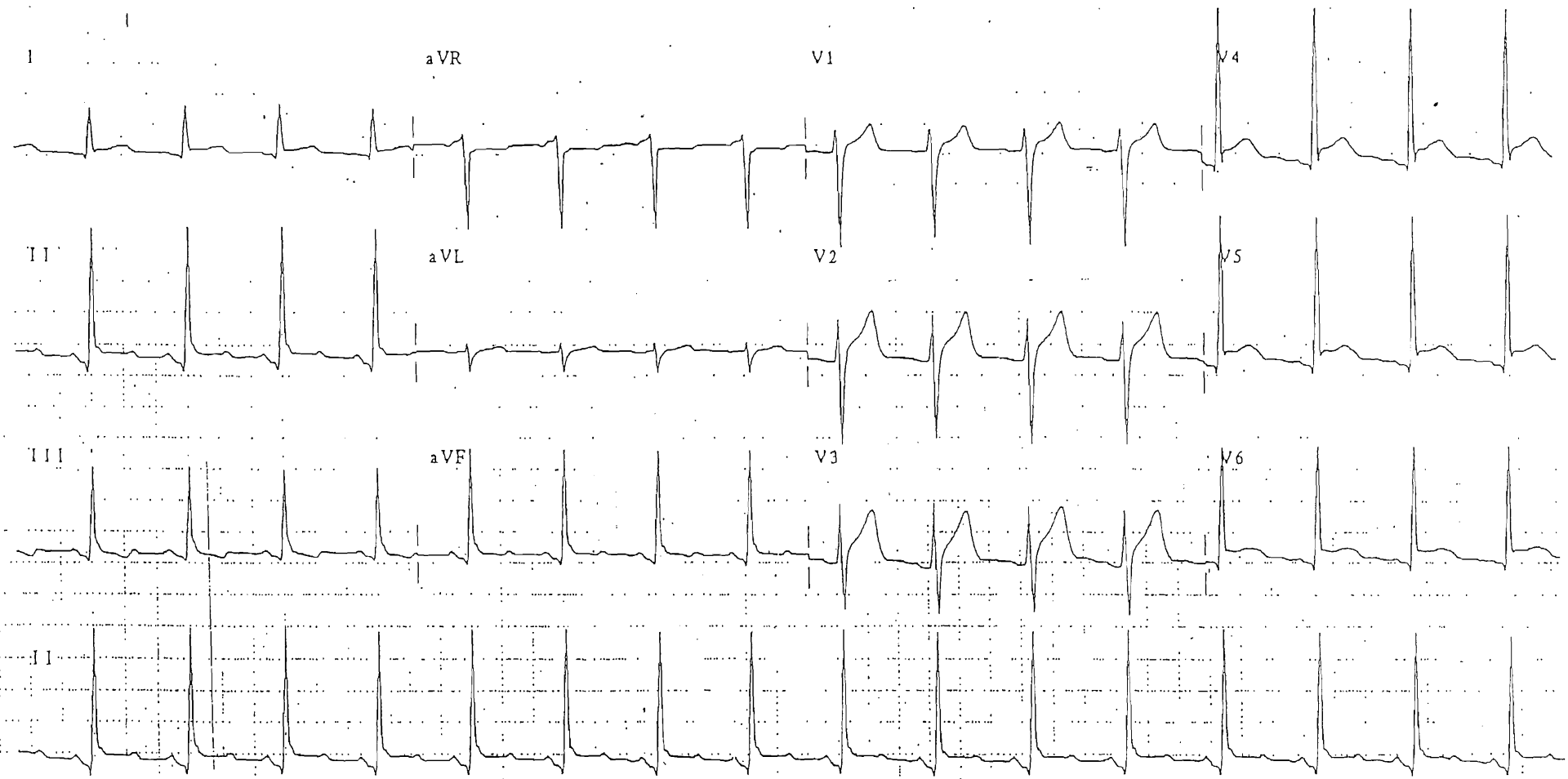
PRELIMINARY-MD MUST REVIEW



Rate 99	. Normal sinus rhythm, rate 99	Normal P axis; PR, rate & rhythm	EKG SIDE
PR 141	. High QRS voltage, ? normal for age	S V1 + R V5,V6 > 3.5mV, age <35	LEFT
QRSD 91	. Widespread ST elev'n, consider Pericarditis	ST > .15 mV ANT/LAT/INF	C/P No.
QT 307			Y
QTc 394			

--AXIS--
P 74
QRS 68
T 33

PRELIMINARY-MD MUST REVIEW



Speed:25 mm/sec Limb:10 mm/mV Chest:10 mm/mV

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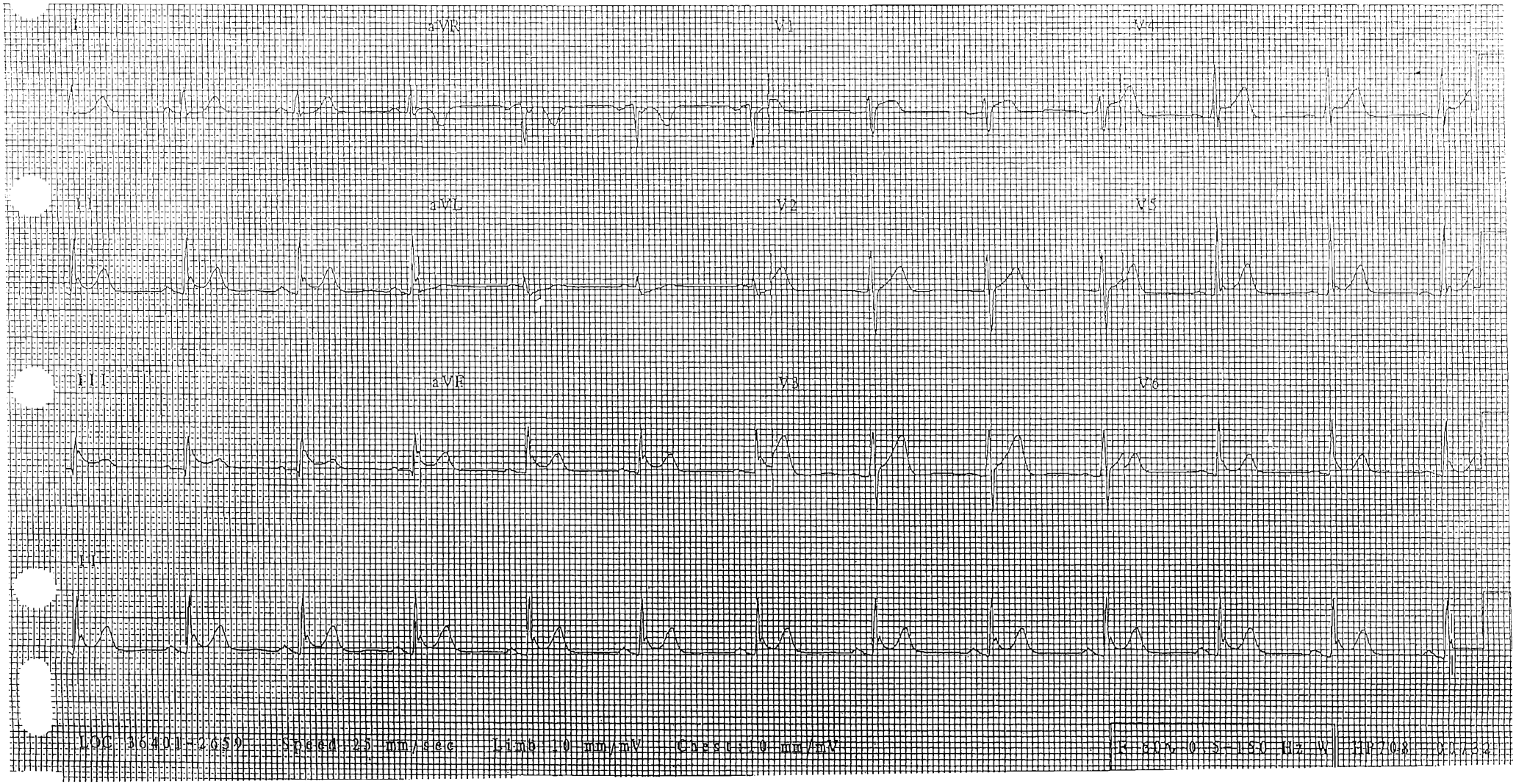
Rate	73	. Normal sinus rhythm, rate 73.....Normal P axis, PR, rate & rhythm
PR	149	. QT interval short for rate.....QTc < 360 mS
QRSD	95	. Widespread ST elevation,consider Pericarditis.....ST > .15 mV ANT/LAT/INF
QT	314	
QTc	346	

Requested by:

--AXIS--

P	38
QRS	67
T	53

PRELIMINARY-MD MUST REVIEW

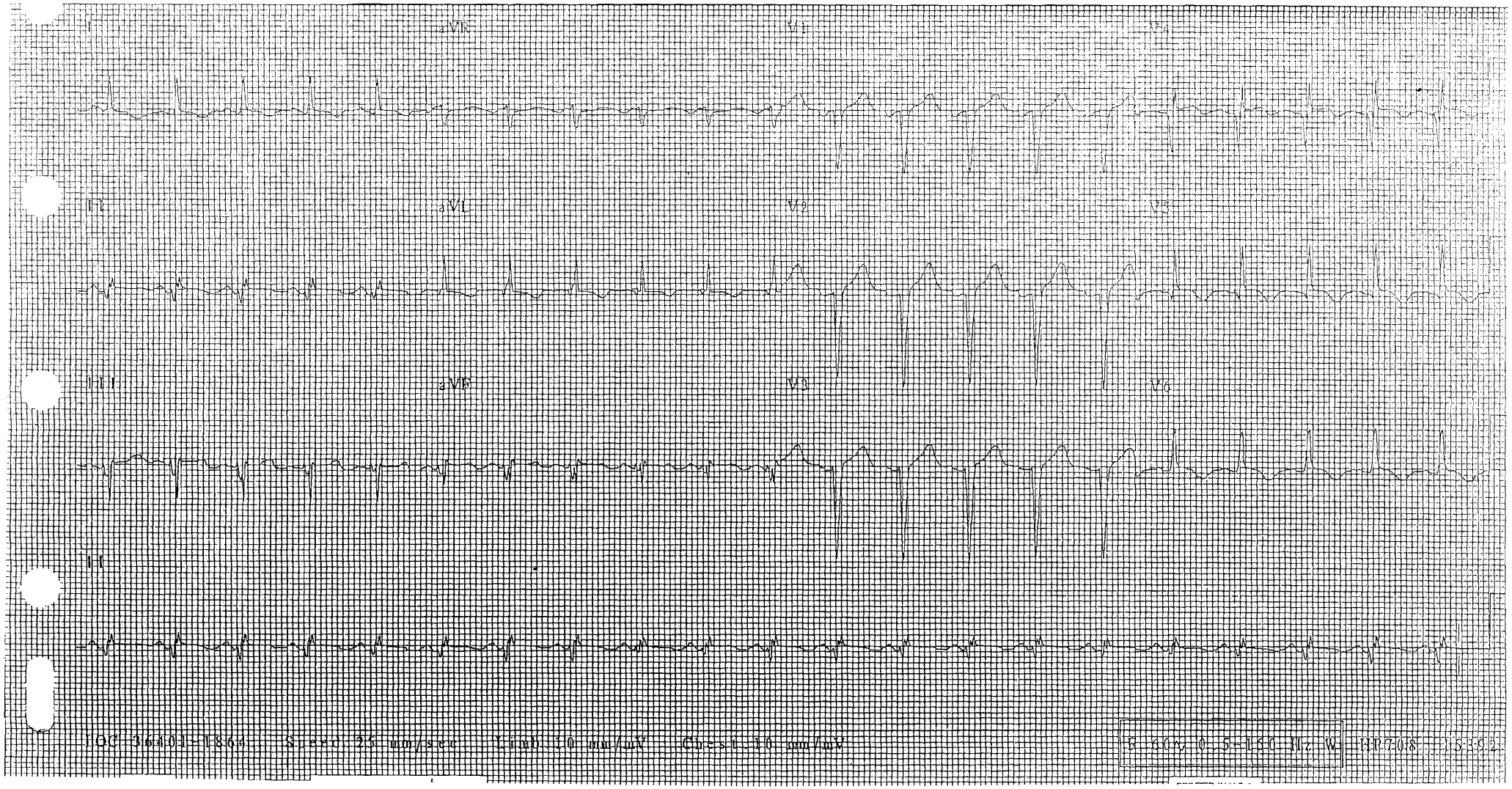


Rate	125	. Sinus tachycardia, rate 125	Normal P axis, rate >= 100
PR	115	. Consider left atrial enlargement	P V1 -.10 mV or more negative
QRSD	85	. Anterior infarct, age indeterminate	Q waves V2-V4, neg T's
QT	285	. Nonspecific Lateral T wave abnormalities	T waves -.20 mV I,aVL,V5,V6
QTc	411	. . Cannot exclude ischemia	T > -.20 mV
		. Borderline ST elevation, inferior leads	ST > .07 mV II,III,aVF

Requested by:

--AXIS--	
P	59
QRS	-4
T	128

PRELIMINARY-MD MUST REVIEW



Rate	81	. Normal sinus rhythm, rate 81	Normal P axis, PR, rate & rhythm
PR	134	. Left anterior fascicular block and	QRS axis -45 deg., QRS > 120 mS
QRSD	124	nonspecific intraventricular conduction	
QT	401	delay	
QTc	465	. Left atrial enlargement	P' -.10 mV and 40 mS in V1
		. Anterior infarct, possibly acute	Q waves V2-V4, ST +.15 mV
--AXIS--		. Nonspecific Lateral T wave abnormalities	T waves -.10 mV I,aVL,V5,V6
P	36		
QRS	-60		
T	129		

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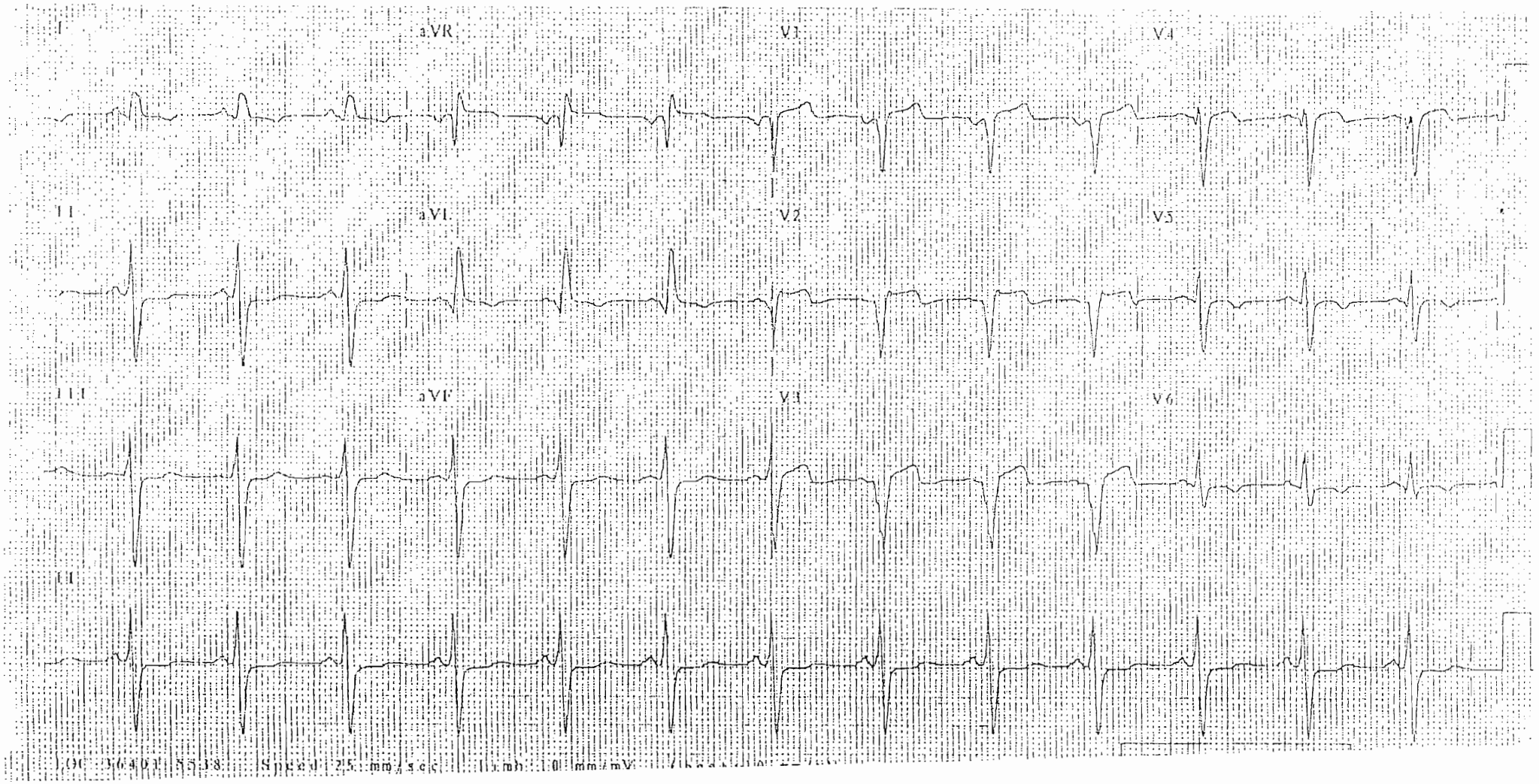
PRELIMINARY-MD MUST REVIEW



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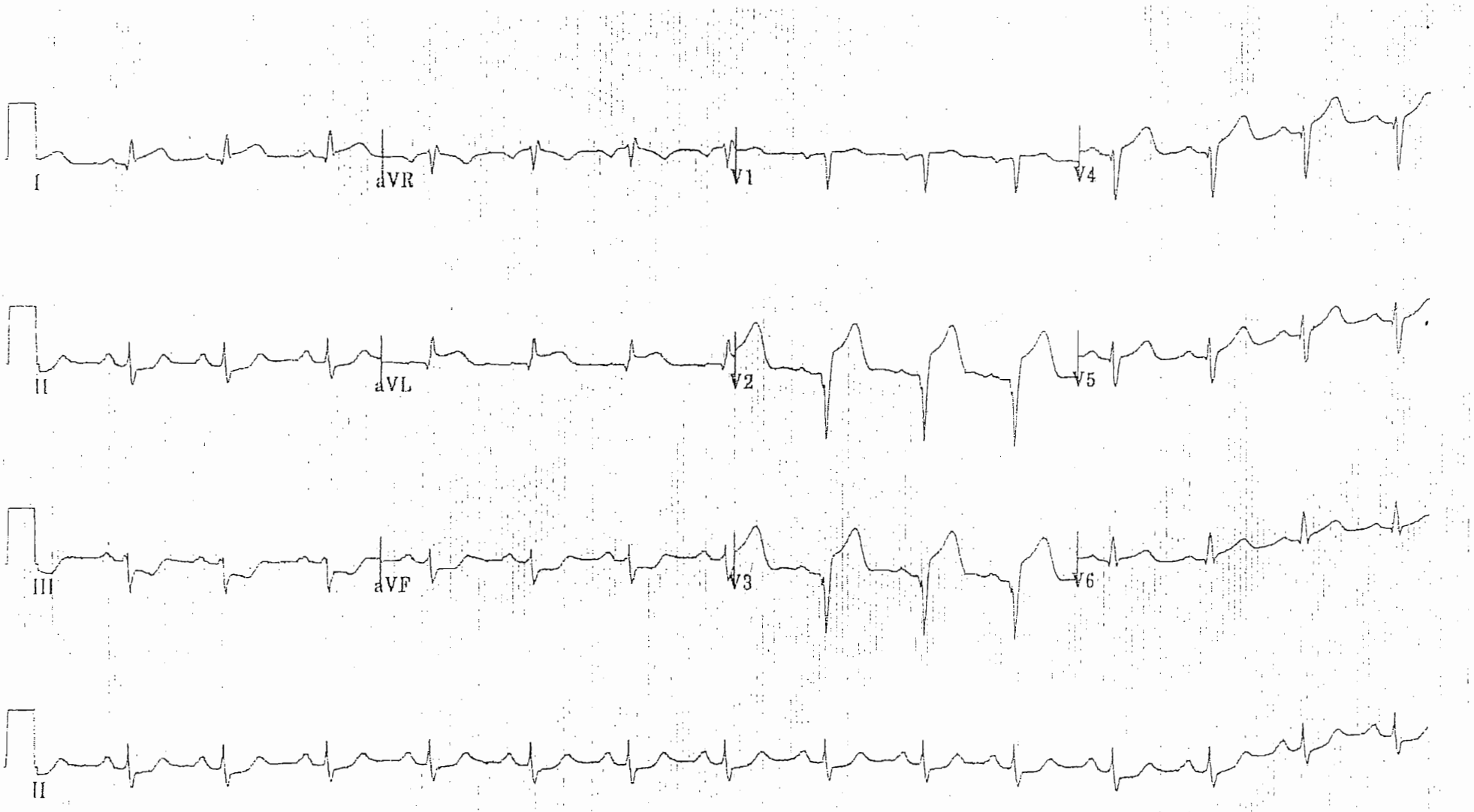
62years
Male Caucasian

Room: M2

Vent. rate	85 bpm
PR interval	170 ms
QRS duration	92 ms
QT/QTc	352/418 ms
P-R-T axes	57 -26 -6

Normal sinus rhythm
Anteroseptal infarct, possibly acute
Lateral injury pattern
** ** ** ** * Acute MI * ** ** ** **
Abnormal ECG

Technician:
Test ind:



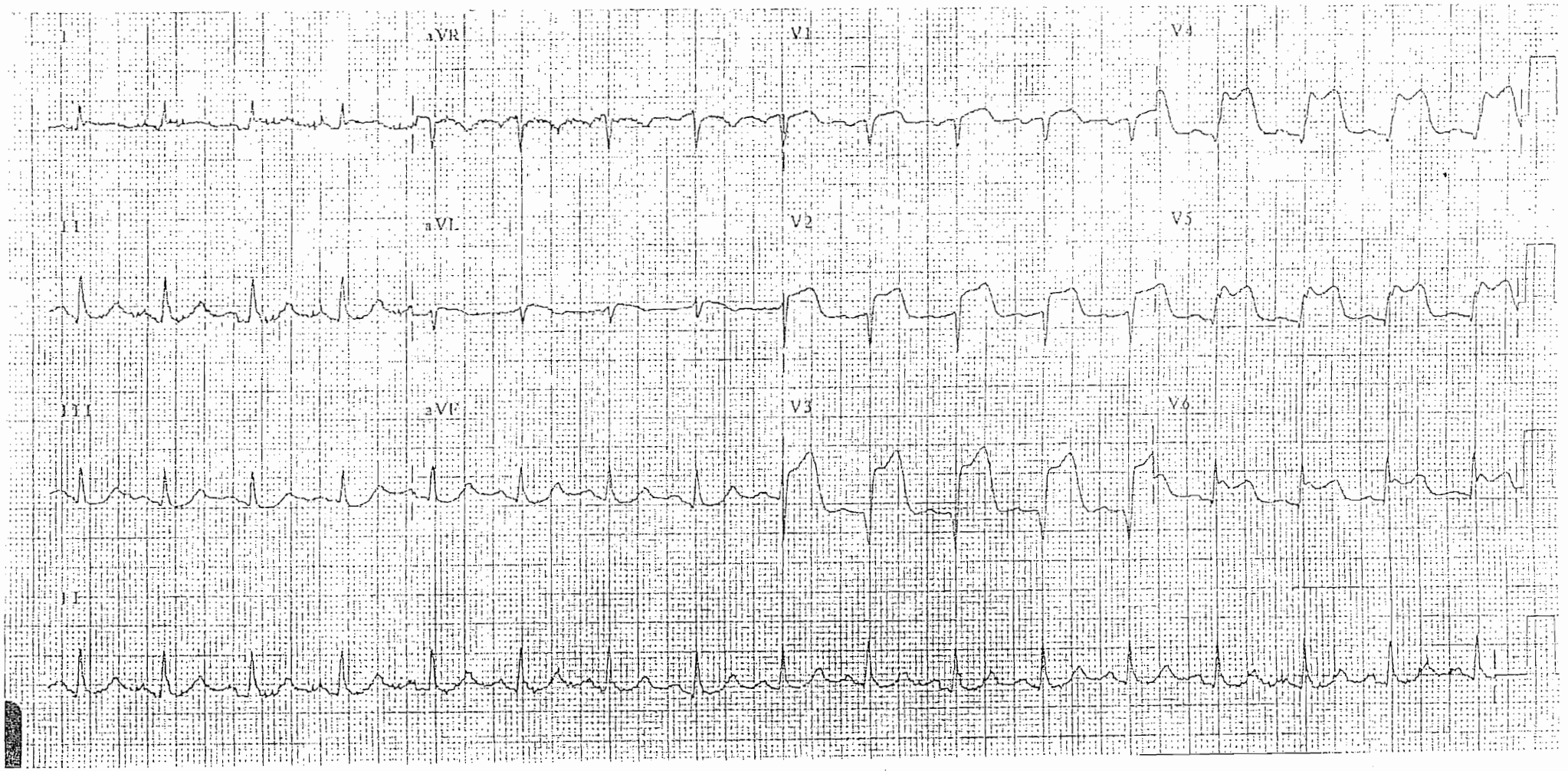
150 Hz 25.0 mm/s 10.0 mm/mV 4 by 2.5s + 1 rhythm ld MAC 8 001G 12SL[m] v250

11:28:53 PM

59 years Male

Rate	100	. Sinus tachycardia, rate 100	Normal P axis, rate >= 100
PR	169	. Borderline intraventricular conduction delay	QRS 110 mS or wider
QRSD	111	. Consider left atrial enlargement	P V1 -.10 mV or more negative
QT	335	. Anterolateral injury (ACUTE INFARCT)	ST > .35 mV in I,aVL,V2-V6
QTc	432		

--AXIS--	
P	61
QRS	64
T	58



15-MAR-99 03:30

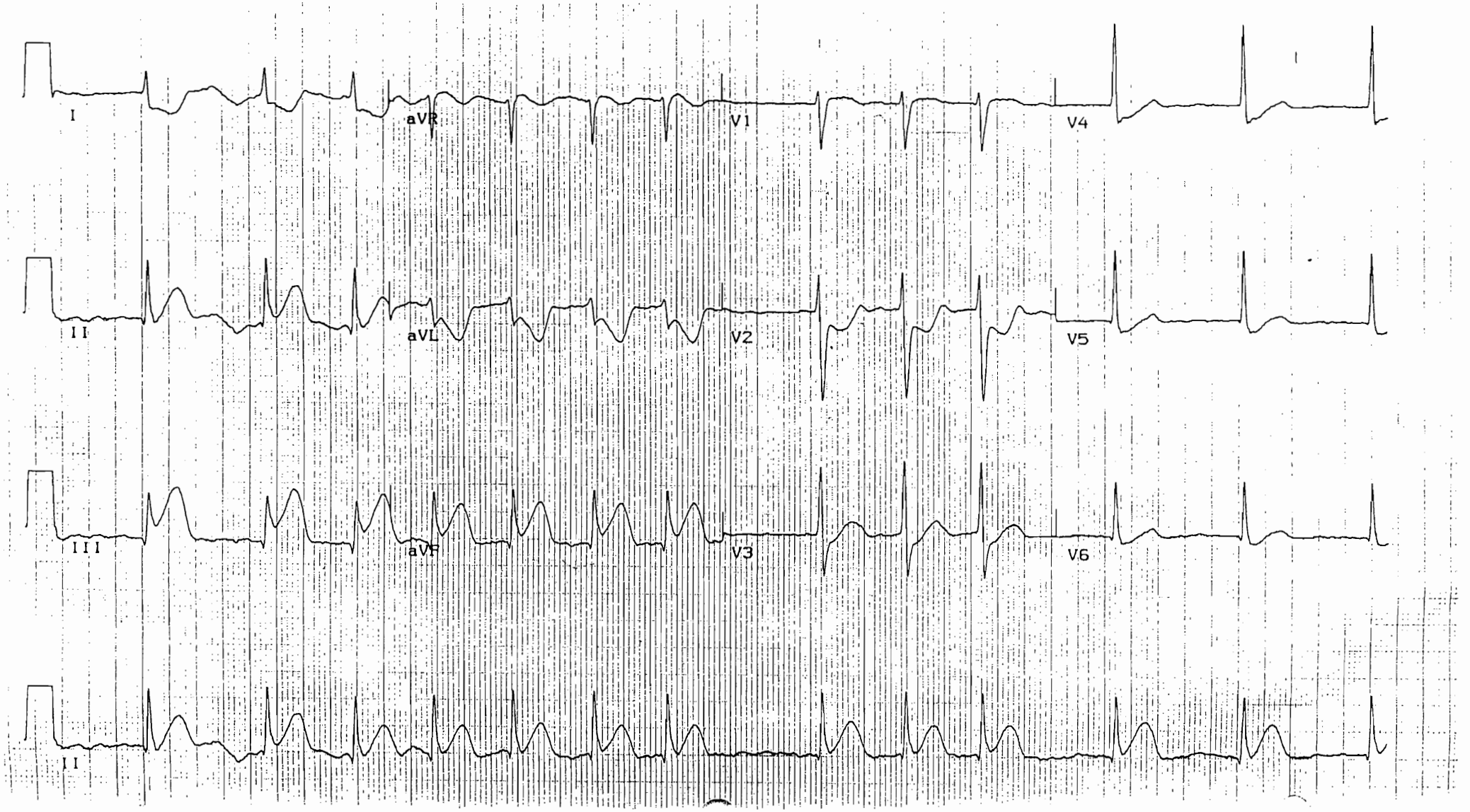
25mm/s
10mm/mV
40Hz
Pgm 007A
12SLtm v78

Med: None
46yr Ht: Wt:
Sex: M Race: Cauc
Loc: 2 Room: 427.9
Option: 96
Vent. rate 78 BPM
PR interval * ms
QRS duration 104 ms
QT/QTc 368/417 ms
P-R-T axes * 66 112

ATRIAL FIBRILLATION
ST ELEVATION CONSIDER INFERIOR INJURY OR ACUTE INFARCT
** ** ** ** * ACUTE MI * ** ** ** **
ABNORMAL ECG

Referred by:

Unconfirmed



ID:

15-MAR-99 04:49

25mm/s
10mm/mV
40Hz
Pgm 107A
12SLtm v78

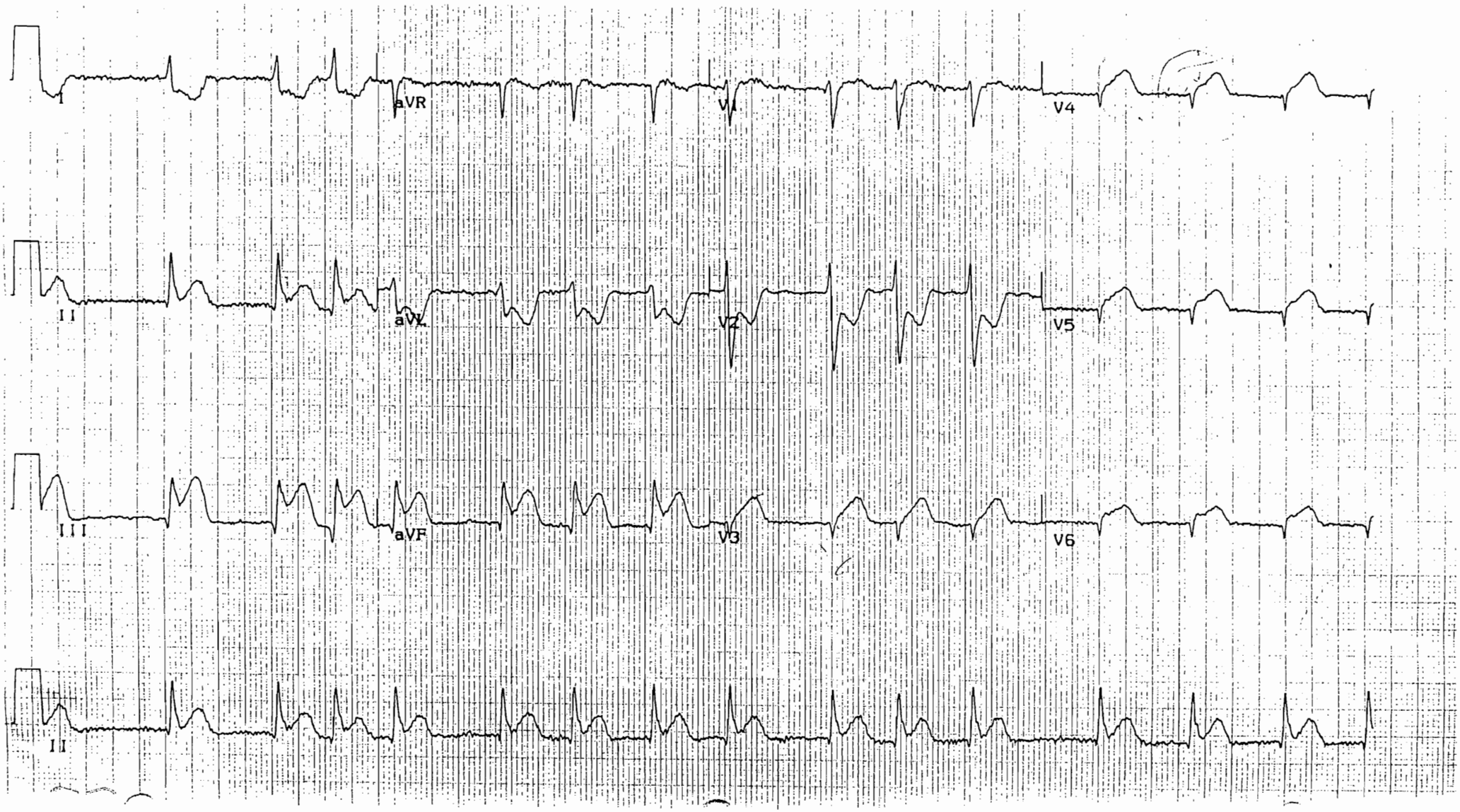
Med: Unknown
47yr Ht: Wt:
Sex: M Race: Cauc
Loc: 50 Room: 5009
Option: 2

Vent. rate	93	BPM
PR interval	*	ms
QRS duration	88	ms
QT/QTc	328/404	ms
P-R-T axes	* 63	117

ATRIAL FIBRILLATION
POSSIBLE ANTEROLATERAL INFARCT, AGE UNDETERMINED
INFERIOR INJURY PATTERN
** ** ** ** * ACUTE MI * ** ** ** **
ABNORMAL ECG

Referred by:

Unconfirmed



25-Mar-2003 17:19:56

26-Apr-1931
Female

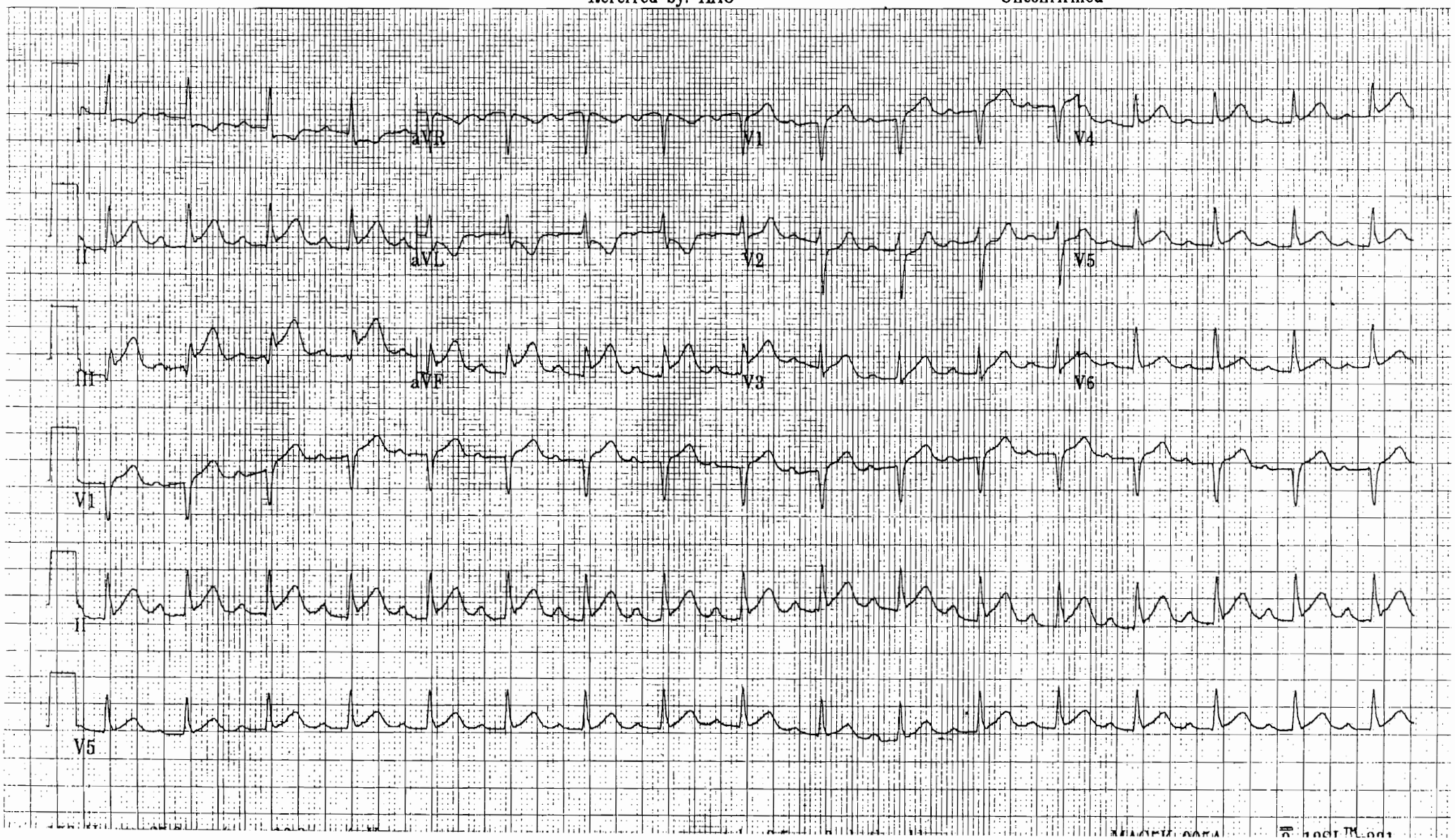
Vent. rate	101	bpm
PR interval	228	ms
QRS duration	84	ms
QT/QTc	316/409	ms
P-R-T axes	66 50 100	

*** Age and gender specific ECG analysis ***
Sinus tachycardia with 1st degree AV block
ST elevation consider inferior injury or acute infarct
** ** ACUTE MI ** **
Abnormal ECG

Technician: CD

Referred by: HAO

Unconfirmed



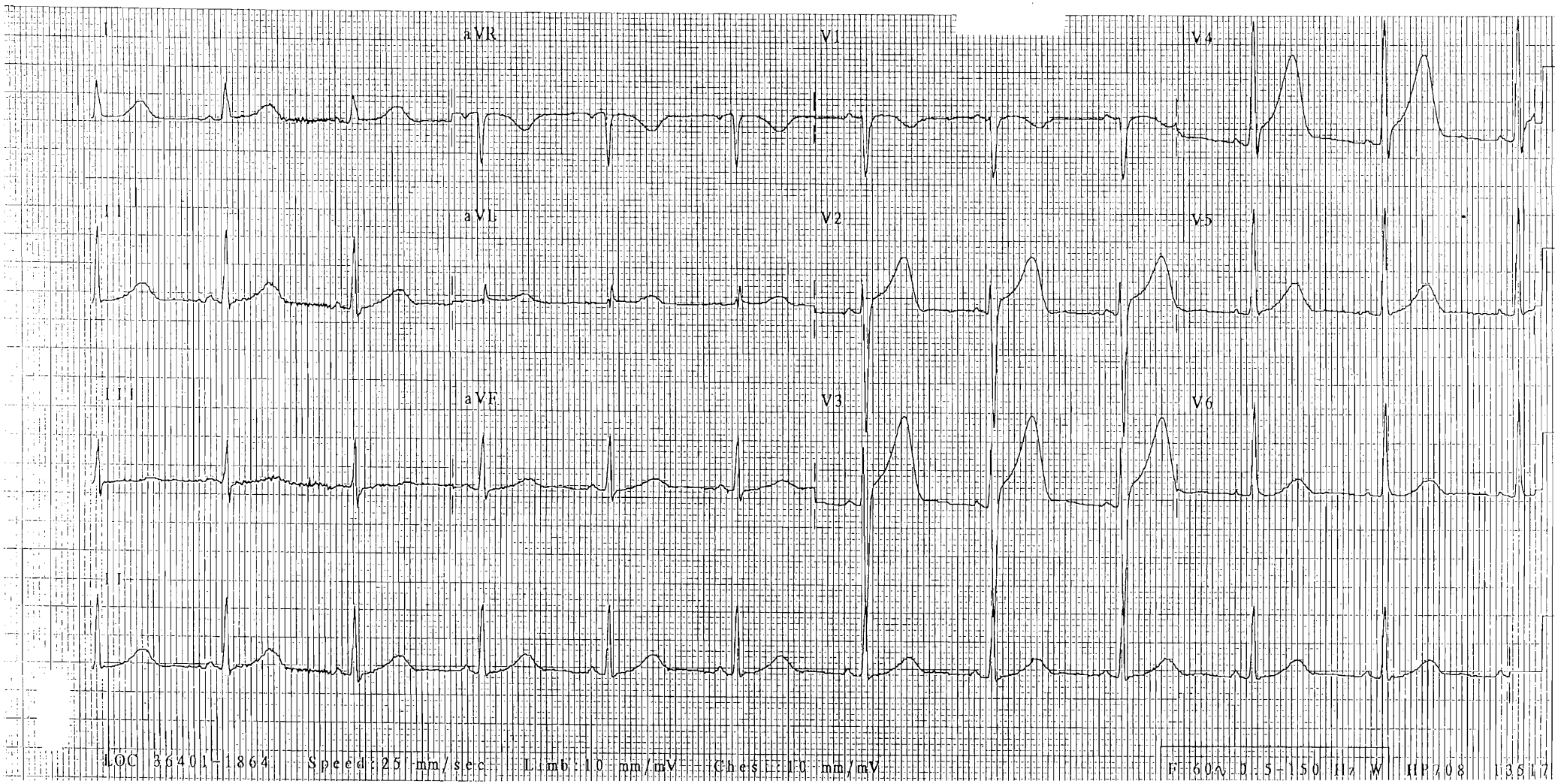
02/23/2003 11:39:46 AM
Female

Rate	66	. Normal sinus rhythm, rate 66	Normal P axis, PR, rate & rhythm
PR	140	. Anterior ST elevation	ST > .20 mV V1-V4
QRSD	85		
QT	434		
QTc	455		

--AXIS--	
P	62
QRS	50
T	36

- BORDERLINE ECG -

PRELIMINARY-MD MUST REVIEW



02/23/2003 01:41:55 PM
Female

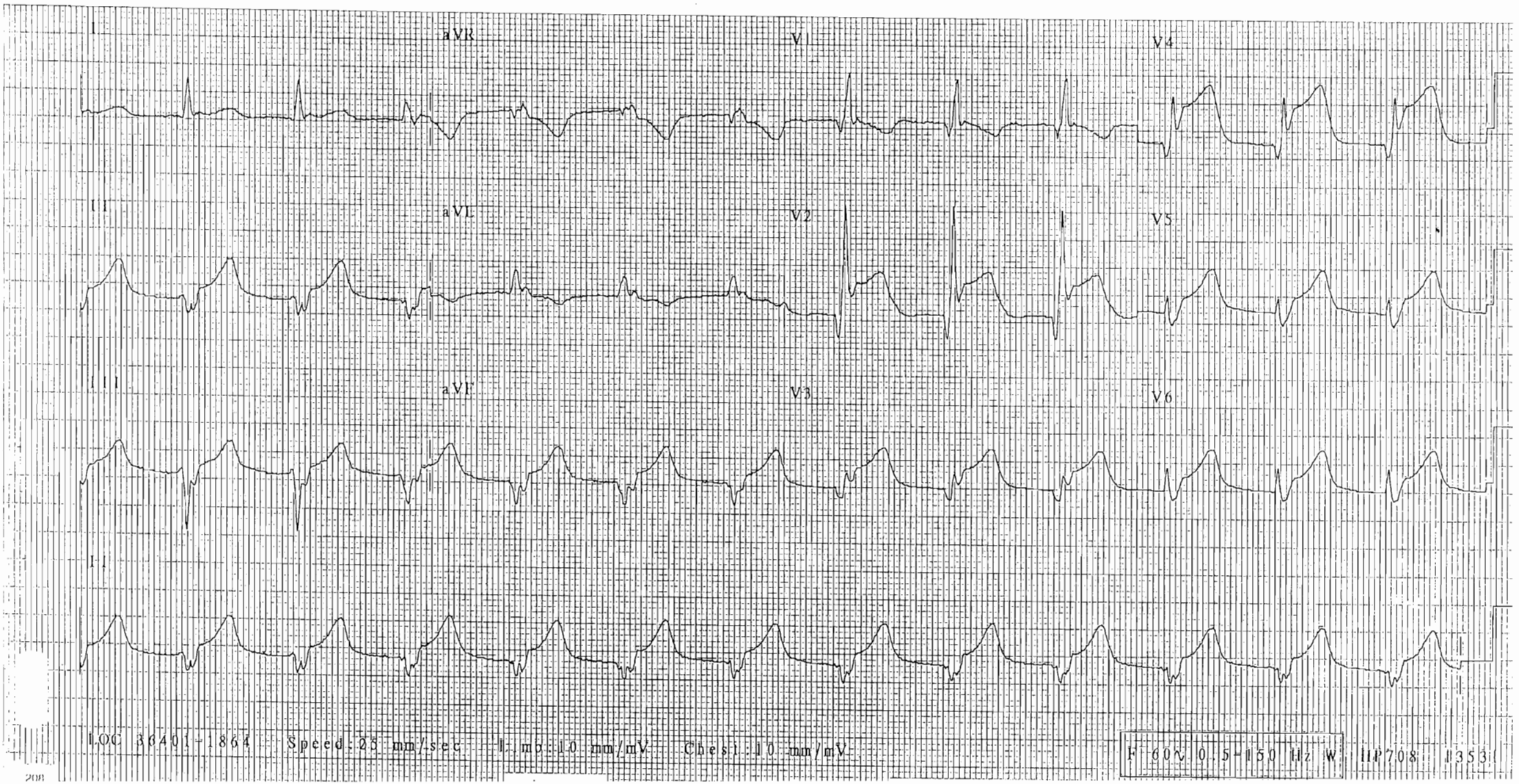
Rate	76	. Regular rhythm with unusual P axis, rate 76....P axis not -30 to 120, norm. rate
PR	175	. Left axis deviation.....QRS axis -31 to -90
QRSD	135	. Nonspecific intraventricular conduction delay.....QRS 120 mS or wider
QT	435	. Consider right ventricular hypertrophy.....Q with large R in V1 or V2
QTc	489	. Inferior infarct, possibly acute.....Q's & ST>.10mV II,III,aVF
		. Acute Extensive Anterior infarct.....Q's in V1-V6, ST +.15 mV

--AXIS--

P	-83
QRS	-58
T	73

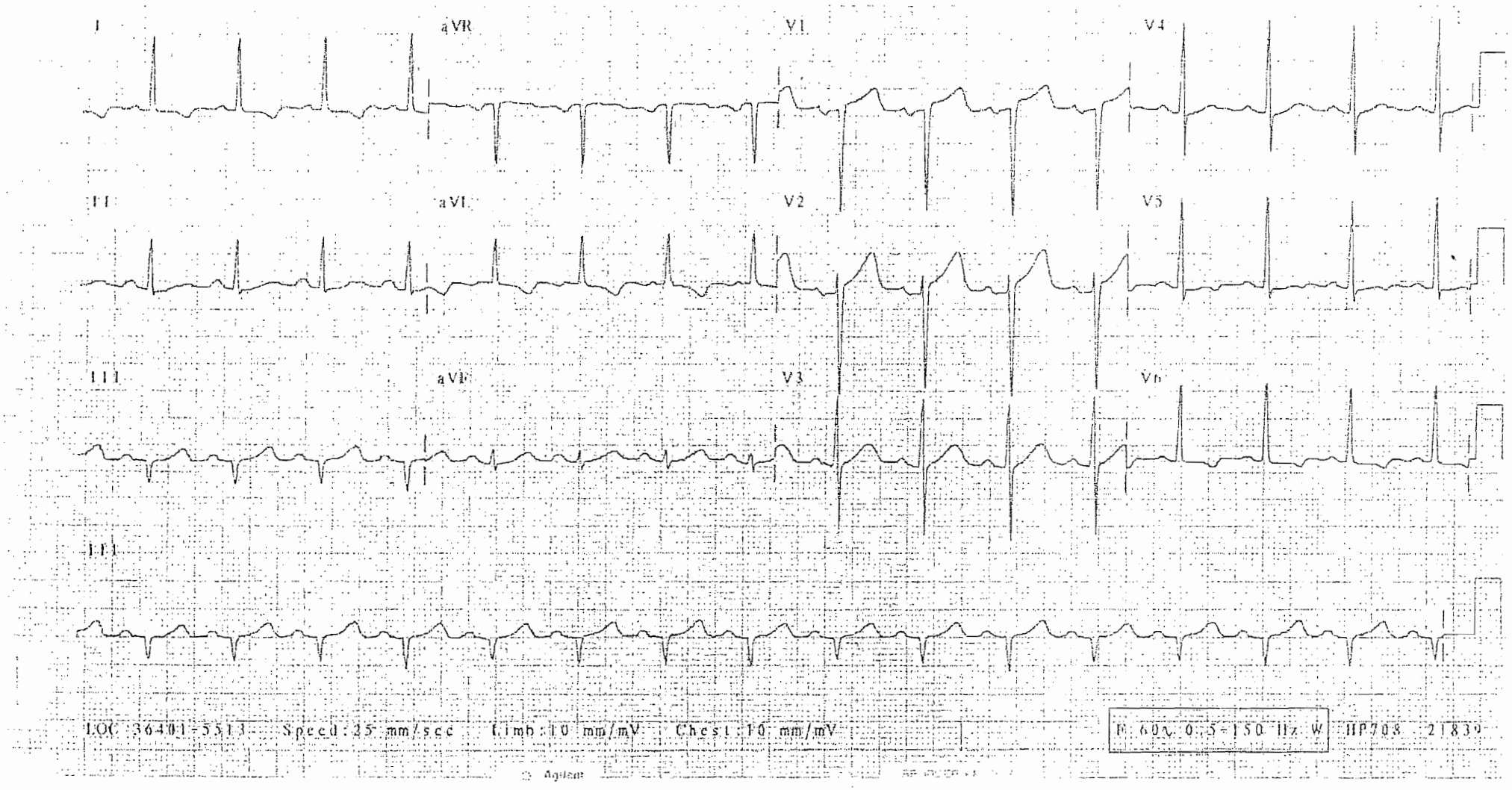
- ABNORMAL ECG -

PRELIMINARY-MD MUST REVIEW



Rate	96	. Normal sinus rhythm, rate 96	Normal P axis, PR, rate & rhythm
PR	177	. Left atrial enlargement	P' -.10 mV and 40 mS in V1
QRSD	64	. LVH with ST-T abnormalities	LVH voltage, LAE, ST-T negative
QT	334	. Anterior ST elevation probably due to LVH	ST > .20 mV V1-V4 & LVH
QTc	422		

--AXIS--	
P	69
QRS	6
T	126

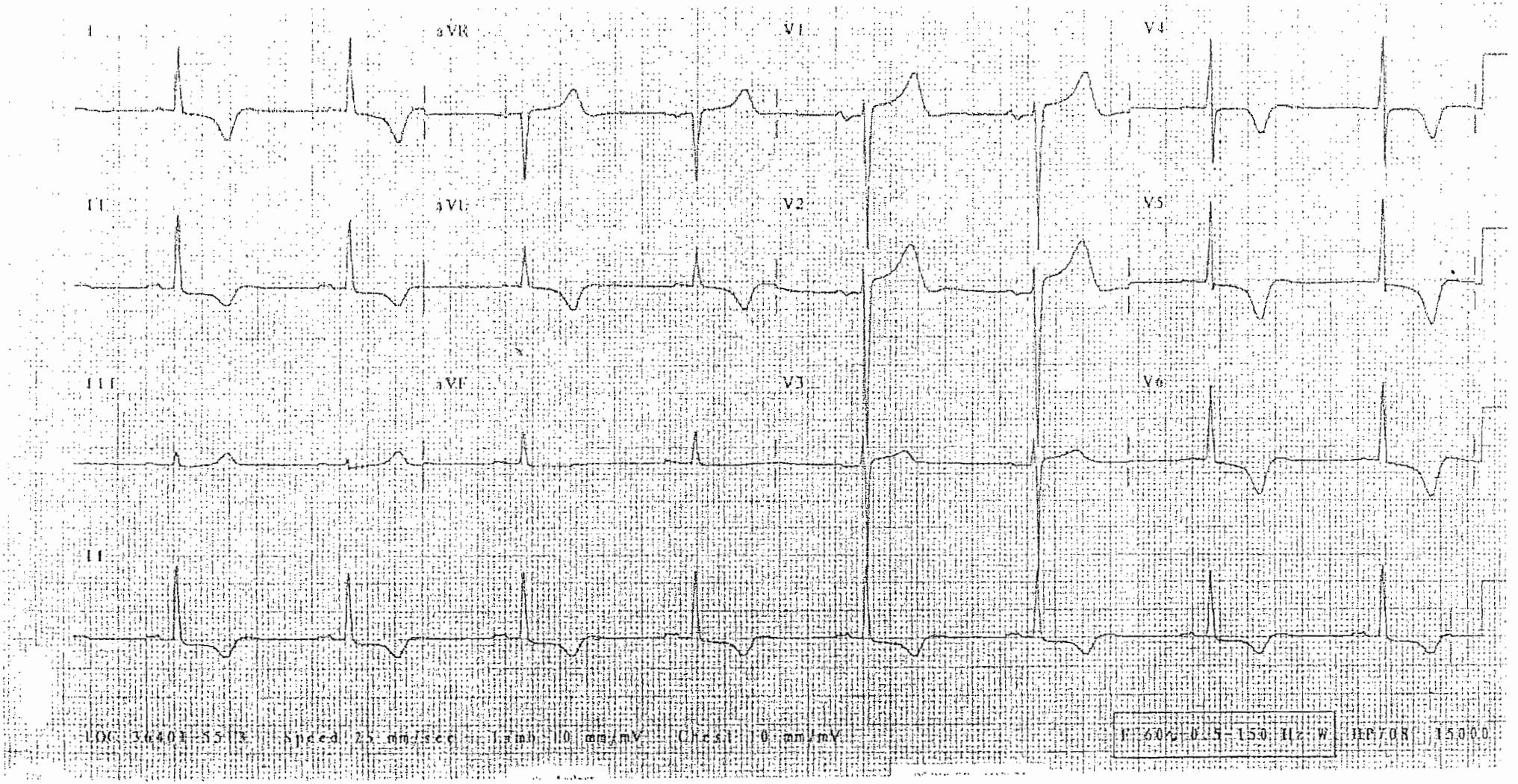


Rate	48
PR	191
QRSD	80
QT	477
QTc	426

--AXIS--

P	56
QRS	31
T	193

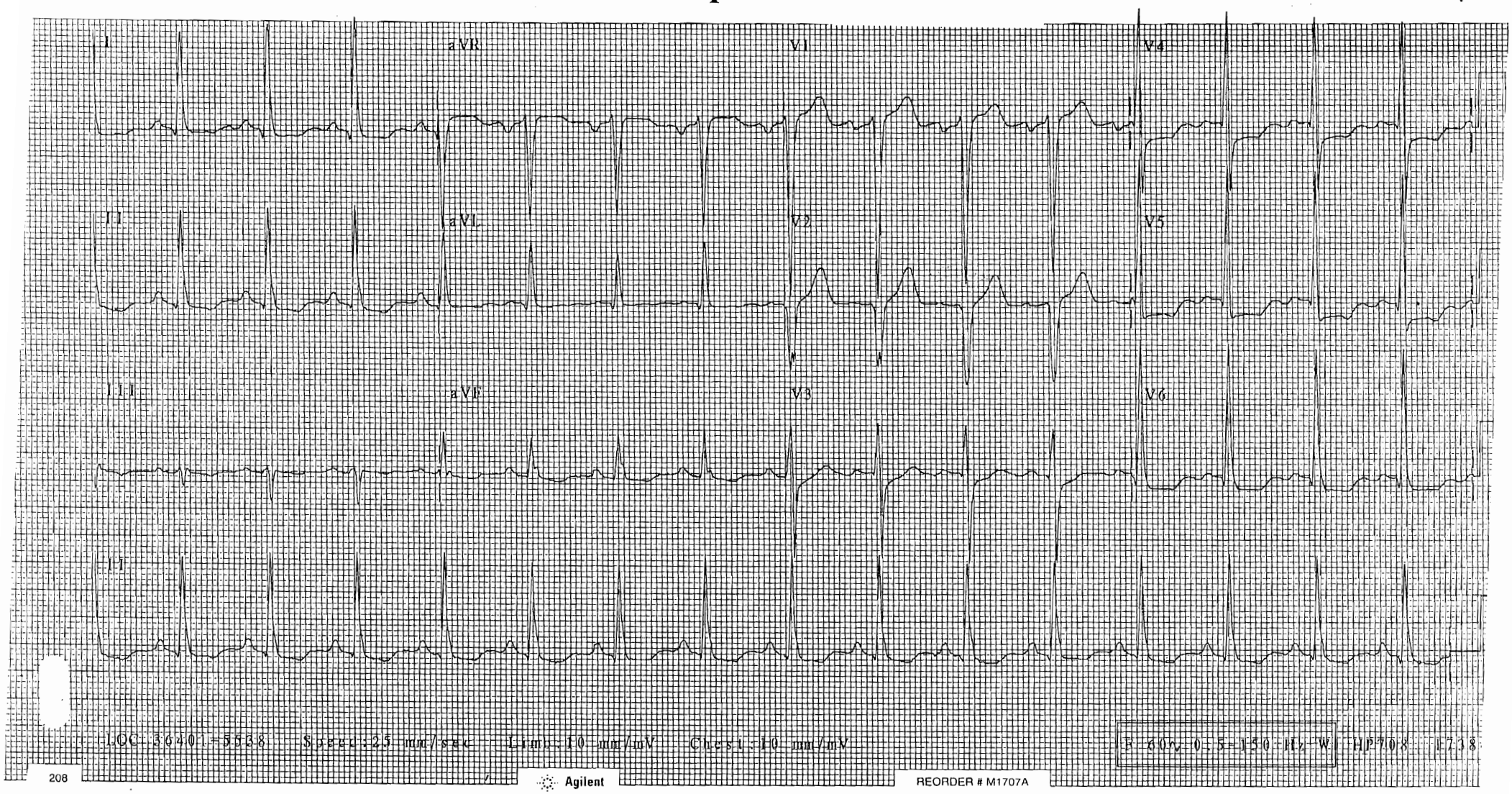
. Sinus bradycardia, rate 48.....Normal P axis, rate < 50
. Left atrial enlargement.....P' -.10 mV and 40 mS in V1
. LVH with ST-T abnormalities.....LVH voltage, LAE, ST-T negative
. Anterolateral T wave abnormalities.....T waves -.60 mV I,aVL,V2-V6
. . Also consistent with ischemia.....T > -.60 mV
. Anterior ST elevation probably due to LVH.....ST > .20 mV V1-V4 & LVH



Oper:

Rate	94	. Normal sinus rhythm, rate 94.....Normal P axis, PR, rate & rhythm
PR	156	. Consider right atrial enlargement.....P > .24 mV limb lead
QRSD	106	. Consider left atrial enlargement.....P V1 -.10 mV or more negative
QT	338	. LVH with ST-T abnormalities.....LVH voltage, ST neg, QRS/VAT wide
QTc	423	. Anterior infarct, age indeterminate.....Q waves V2-V4, neg T's
		. Anterolateral ST depression,.....ST -.30 mV I,aVL,V2-V6
--AXIS--		. . Also consistent with subendocardial injury.....ST > -.30 mV
P	47	
QRS	25	
T	225	

PRELIMINARY-MD MUST REVIEW



Agilent REORDER # M1707A

79 years Female

Rate	70	. Normal sinus rhythm, rate 70.....Normal P axis, PR, rate & rhythm
PR	160	. Left bundle branch block.....QRS 120 mS, terminal forces left
QRSD	154	
QT	466	
QTc	503	

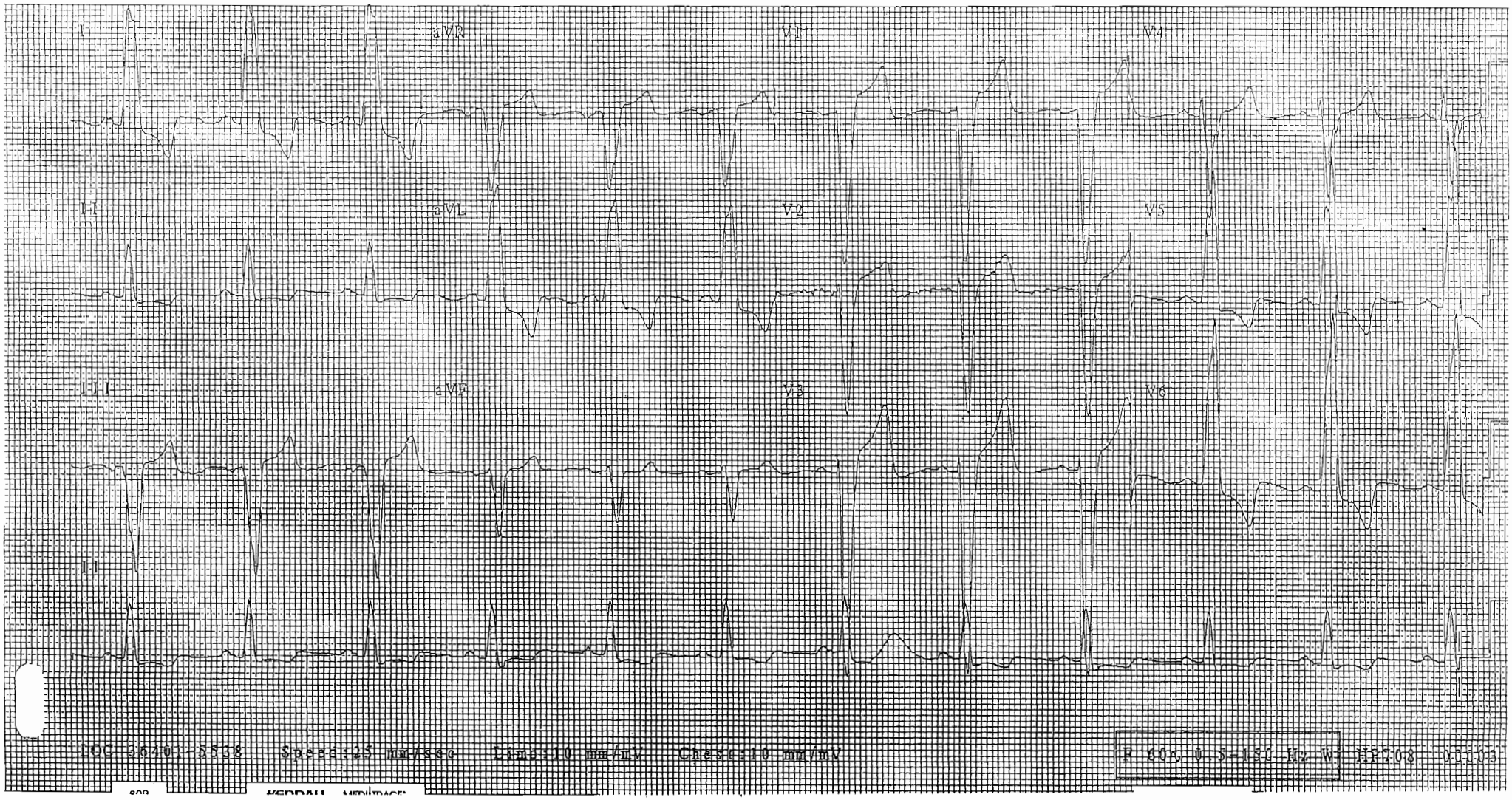
--AXIS--

P	2
QRS	-18
T	158

Requested by:

- ABNORMAL ECG -

PRELIMINARY-MD MUST REVIEW

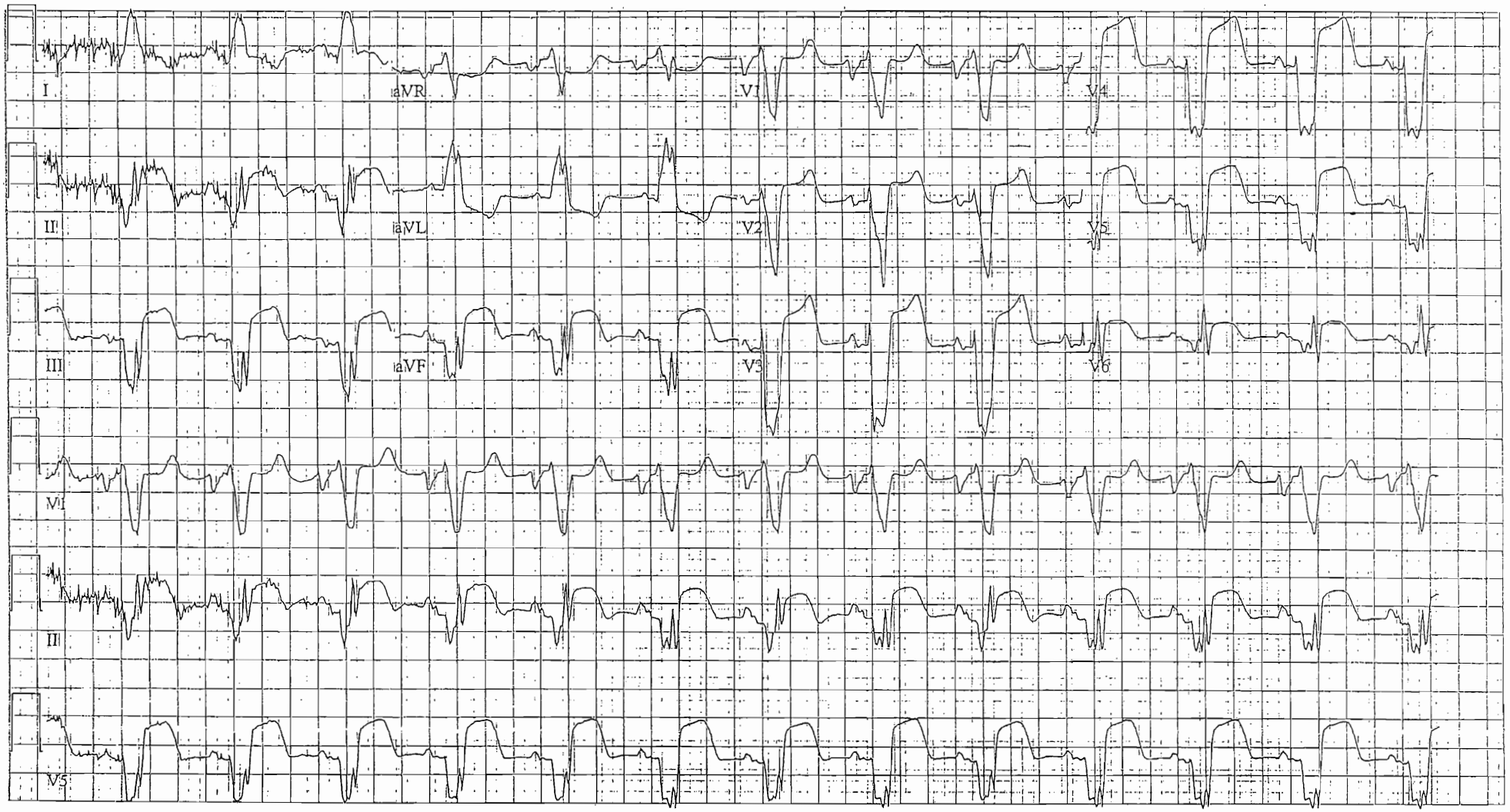


13:15:00

	(71 yr)	Vent. rate	78	BPM	Normal sinus rhythm
Female	Black	PR interval	146	ms	Left atrial enlargement
		QRS duration	179	ms	Non-specific intra-ventricular conduction block
		QT/QTc	463/527	ms	Possible Lateral infarct , age undetermined
Loc:7		P-R-T axes	39 -50	104	Inferior infarct , age undetermined
					Abnormal electrocardiogram

Unauthorized use is prohibited.

Confirmed By:



25mm/s 10mm/mV 100Hz 005E 12SL 86 CID: 1

SID: 107 EID:42 EDT: 20:20 16-AUG-2006 ORDER:

08:31:54 PM

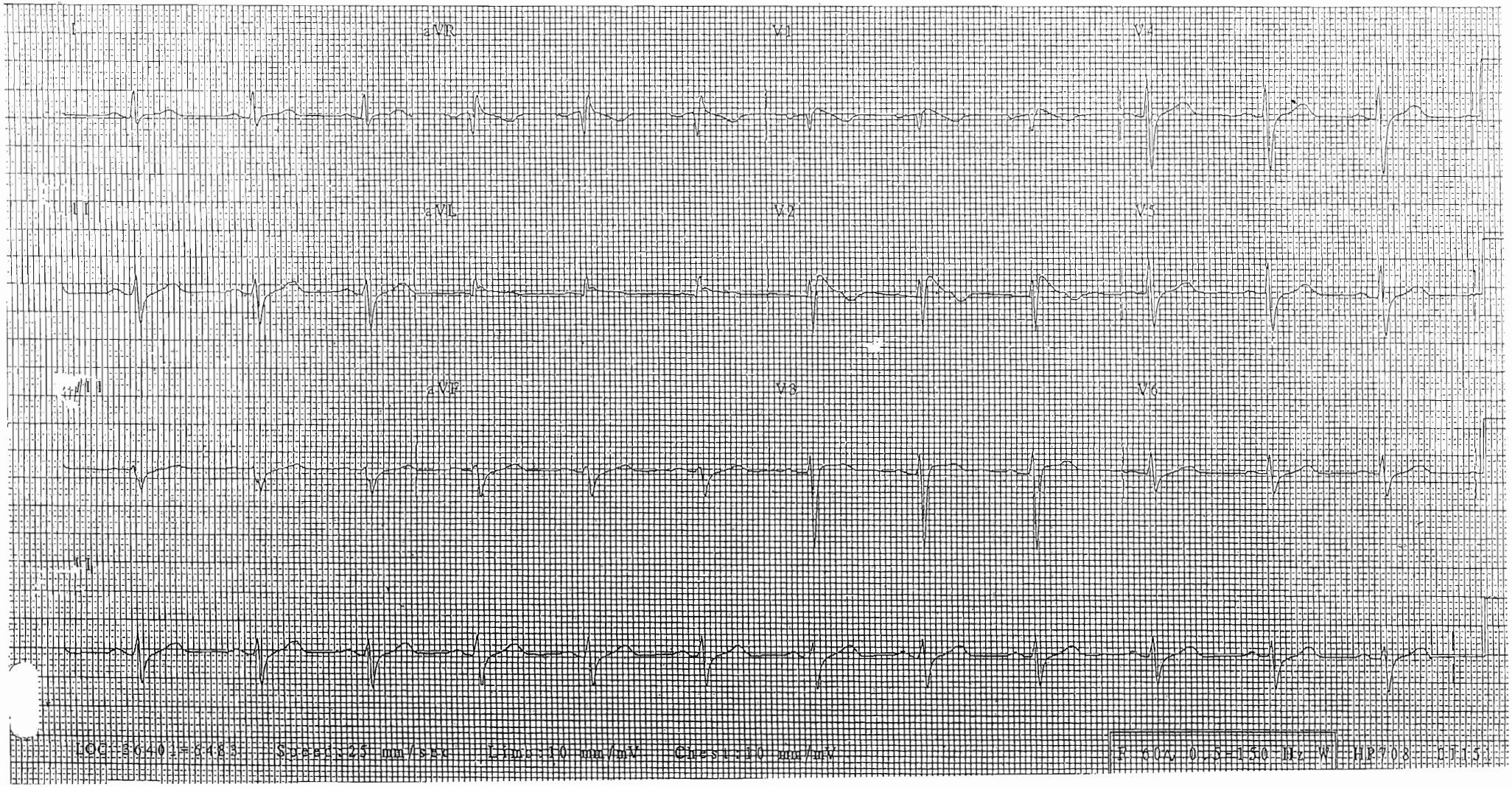
Rate	74	Normal sinus rhythm, rate 74	Normal P axis, PR, rate & rhythm
PR	174	Left anterior fascicular block	QRS axis -45 deg., I:40 inferior
QRSD	112	Late transition	QRS negative in V5 or V6
QT	355		
QTc	394		

Requested by:

--AXIS--

P	46
QRS	-60
T	48

PRELIMINARY-MD MUST REVIEW

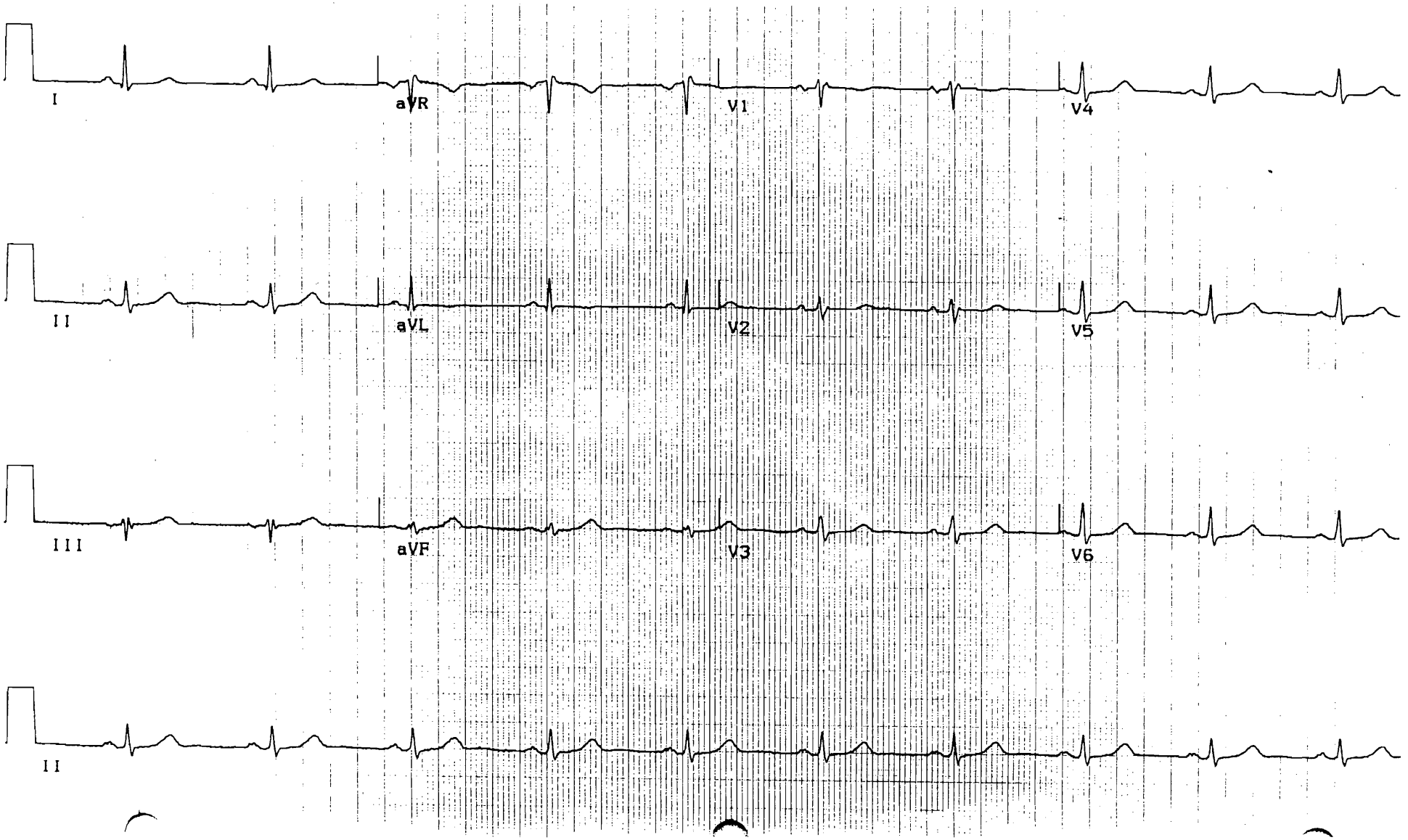


25mm/s
10mm/mV
40Hz
Pgm 107A
12SLtm v78

Med: Unknown
64yr Ht: Wt:
Sex: F Race: Cauc
Loc: 42 Room: 4210
Option: 2
Vent. rate 60 BPM
PR interval 144 ms
QRS duration 88 ms
QT/QTc 432/432 ms
P-R-T axes 26 8 62

NORMAL SINUS RHYTHM
LOW VOLTAGE QRS
BORDERLINE ECG

Unconfirmed

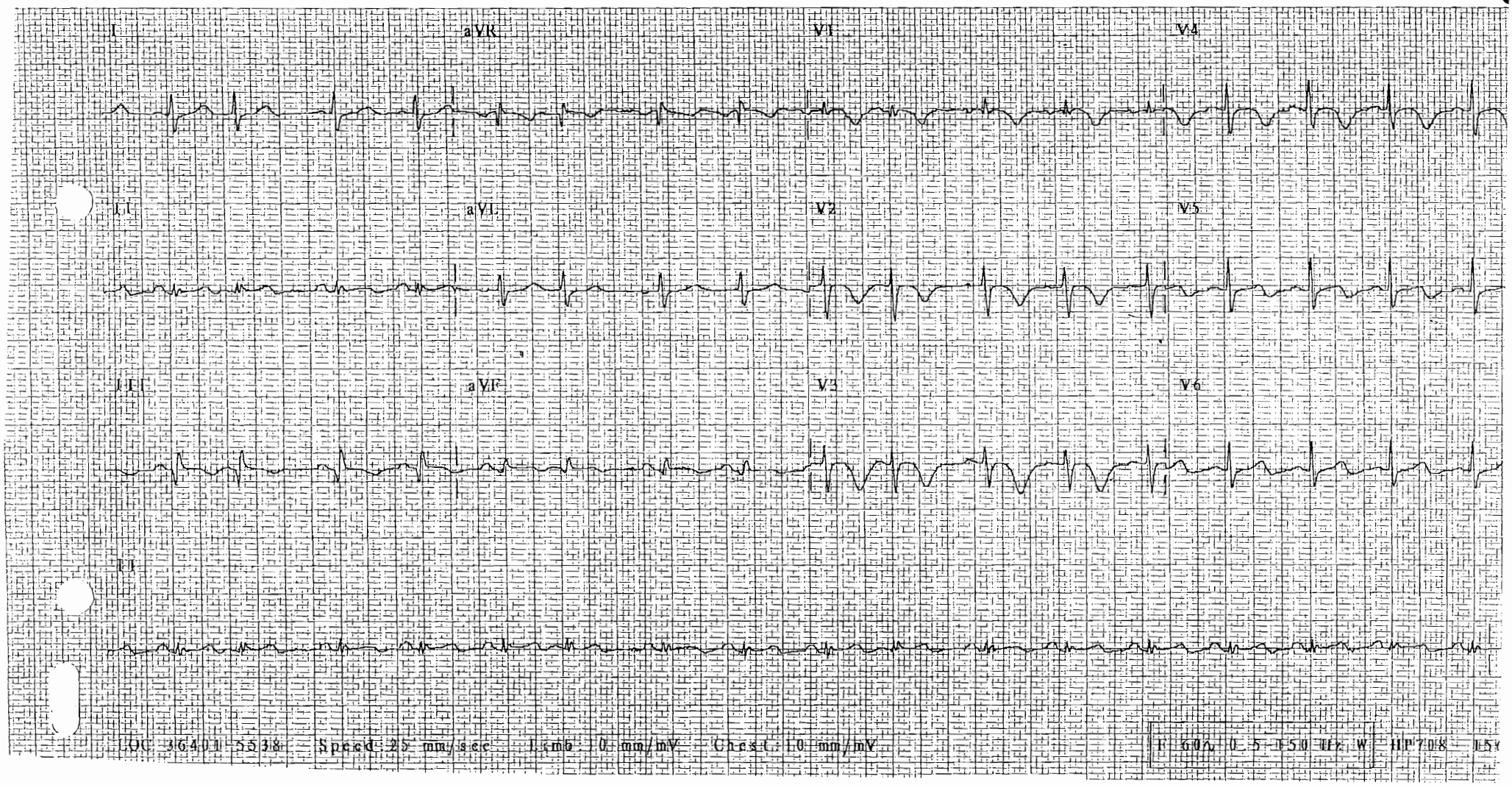


Rate	105	. Sinus arrhythmia. V-rate from 85 to 135.....V-rate varies,mean>=100, normal P
PR	133	. Rightward axis.....QRS axis 91 to 110
QRSD	78	. Diffuse T wave abnormalities,.....T waves -.30 mV ANT/LAT/INF
QT	345	. . Possible ischemia.....T > -.30 mV
QTc	456	

--AXIS--	
P	68
QRS	96
T	-18

MD

PRELIMINARY-MD MUST REVIEW



08/14/2000 01:04:45 AM

Dx:

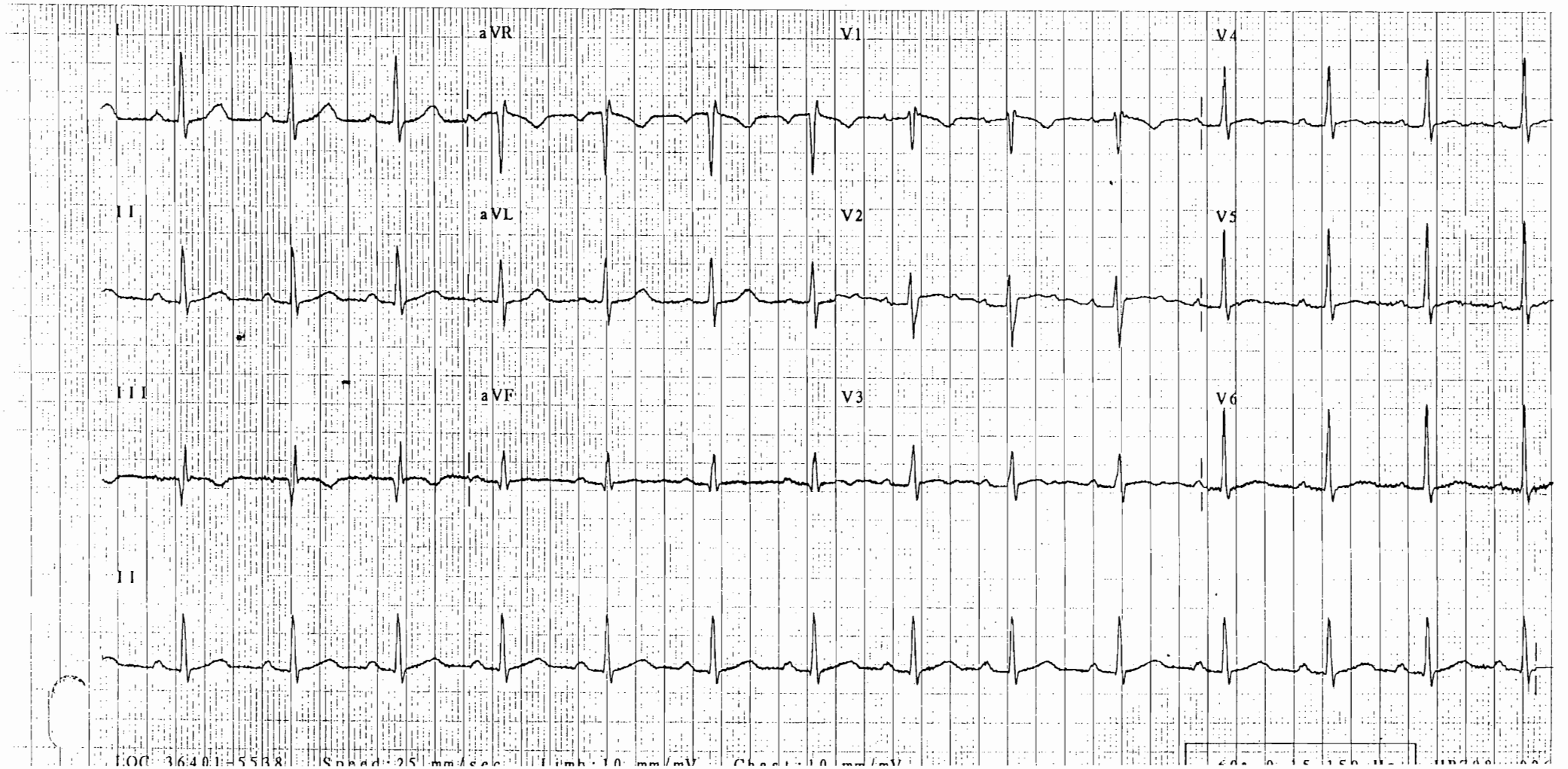
. Normal sinus rhythm, rate 84.....Normal P axis, PR, rate & rhythm
. RSR' in V1 or V2

Rate	84
PR	187
QRSD	80
QT	348
QTc	411
--AXIS--	
P	36
QRS	28
T	10

Requested by:

- OTHERWISE NORMAL ECG -

PRELIMINARY-MD MUST REVIEW



17-MAR-99 16:37

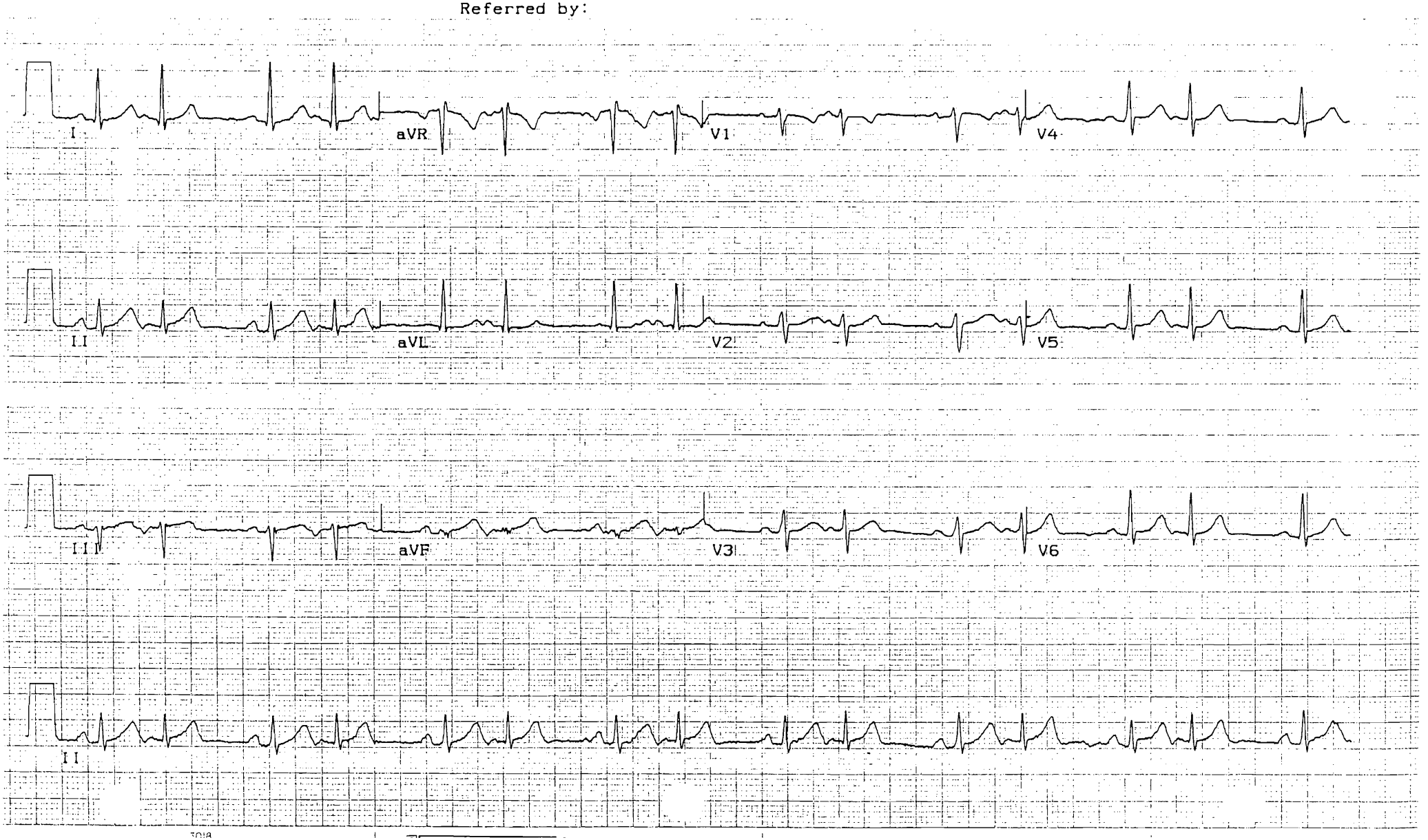
25mm/s
10mm/mV
40Hz
Pgm 007A
12SLtm v78

Med:
34yr Ht: Wt:
Sex: F Race: Cauc
Loc: 2 Room: 427.9
Option: 84

Vent. rate	90	BPM
PR interval	152	ms
QRS duration	80	ms
QT/QTc	372/452	ms
P-R-T axes	58 -2	46

NORMAL SINUS RHYTHM WITH FREQUENT PREMATURE ECTOPIC COMPLEXES
OTHERWISE NORMAL ECG

Referred by:



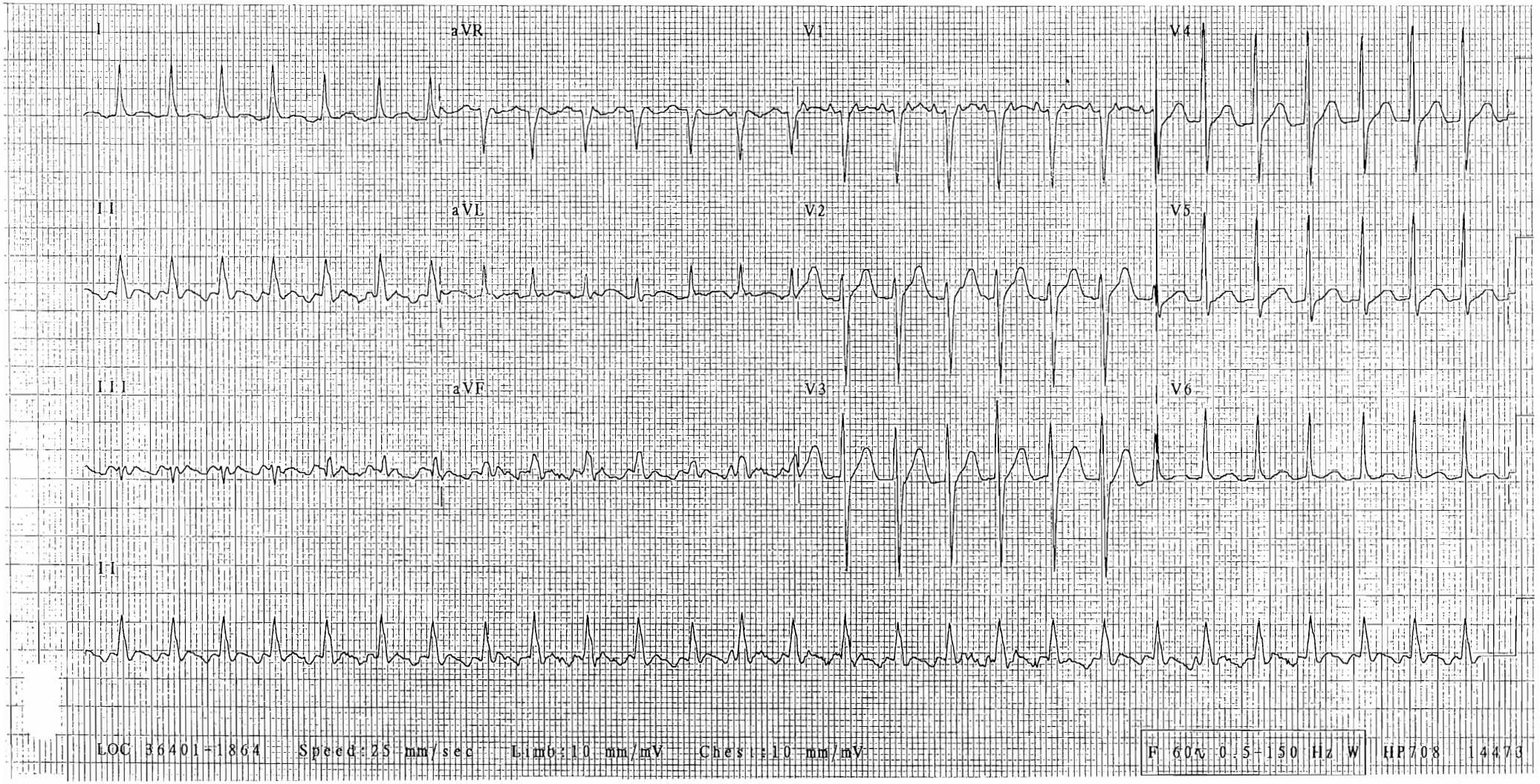
Rate	164	. Supraventricular tachycardia, rate = 164	V-rate > (220-age) or 150
PR	124	. Nonspecific Inferior T wave abnormalities	T wave -.20 mV II,III,aVF
QRSD	98	. . Cannot exclude ischemia	T > -.20 mV
QT	260		
QTc	429		

--AXIS--

P	84
QRS	28
T	-54

- ABNORMAL ECG -

PRELIMINARY-MD MUST REVIEW



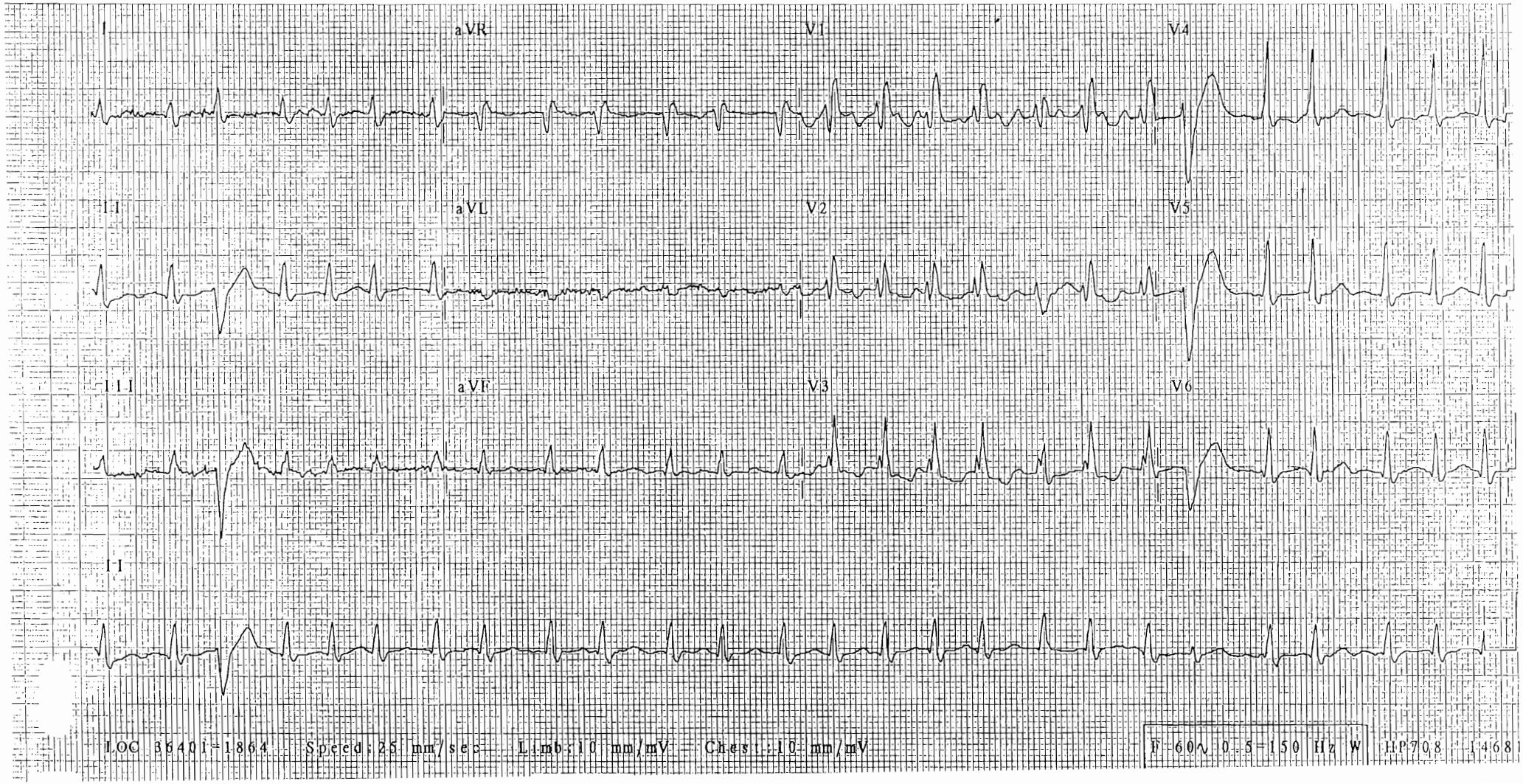
Rate	153	. Atrial fib. w/rapid ventr. response. Rate=153.....V-rate > 150 with variation
PR		. Vertical axis, unusual for age.....QRS axis 81 to 90 & age > 40
QRSD	121	. Right bundle branch block.....QRS 120 mS, terminal forces right
QT	281	
QTc	448	

--AXIS--

P	Ind.
QRS	88
T	29

- ABNORMAL ECG -

PRELIMINARY-MD MUST REVIEW



26 AUG 2000 7:35:12

82 yrs Female

PR	273	. Bigeminy pattern. Mean ventricular rate = 66 - - - - - - Bigeminy pattern recognized
QRSD	127	. Right axis deviation - - - - - - - - - - - - - - - QRS axis 91 to 269 & age > 40
QT	502	. Right bundle branch block - - - - - - - - - - - - - QRS 120 mS, terminal forces right
QTc	526	. Inferior infarct - - - - - - - - - - - - - - - - - 3 Q's 2,3,F & I:40 -30 to 240

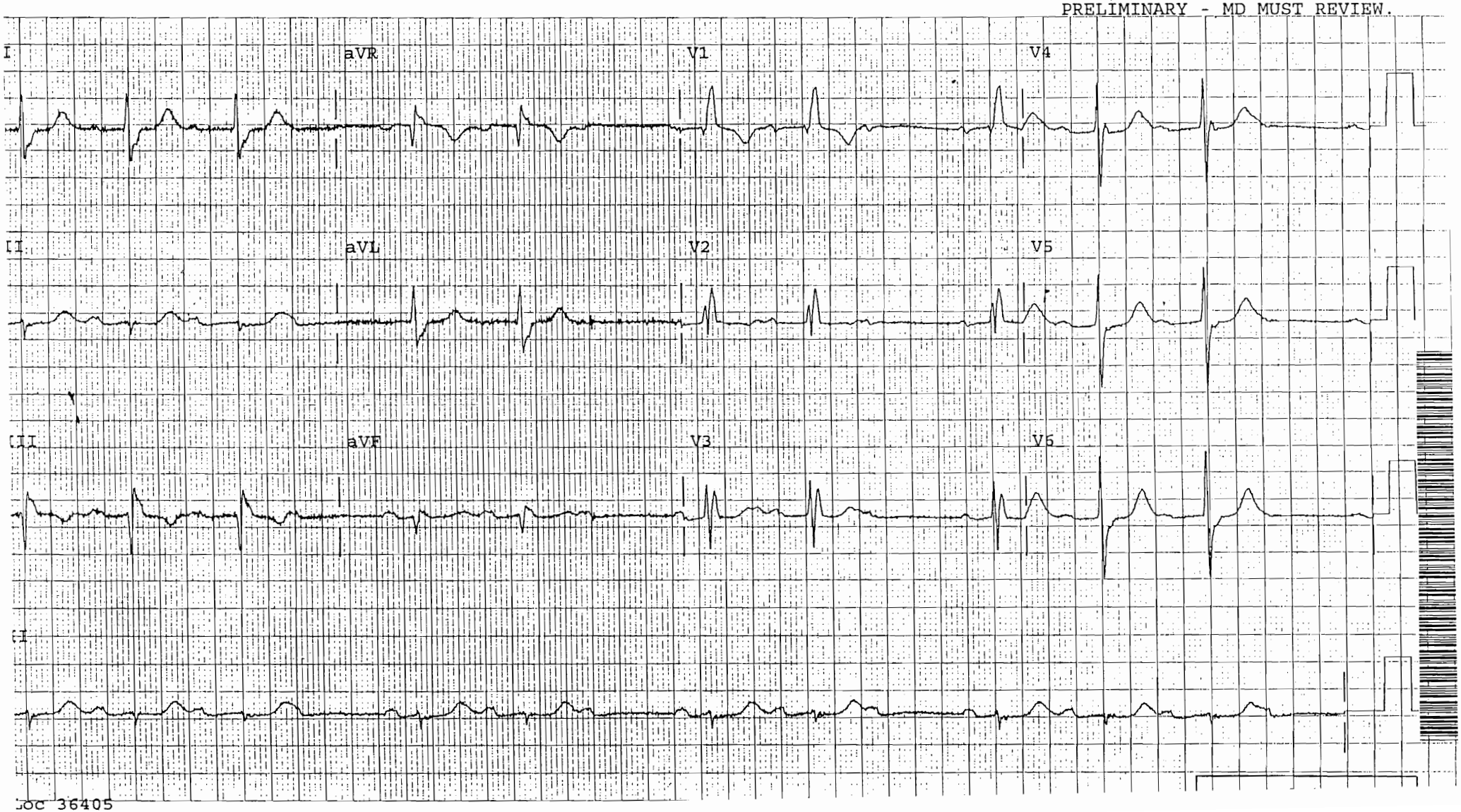
- ABNORMAL ECG -

--AXES--

P	IND
QRS	194
T	14

C-HP708

PRELIMINARY - MD MUST REVIEW.



Soc 36405