

I. OVERVIEW OF THE ECG

Marked bradycardia (mean 36/min), regular until the last 2 QRS complexes which are slightly faster. The QRS complexes are wide (140ms). There are non-conducted P waves.

MORE DETAILED ANALYSIS OF THE ECG

The atrial rate is 106/min, with variable PR interval, so there is AV dissociation. The QT interval is markedly prolonged at 720ms (QTc 557ms). The last 2 complexes have a different morphology to those preceding.

High grade AV block (3:1 and higher ratios of Ps to QRS complexes) requires the presence of at least 1 conducted QRS. The last 2 QRS complexes are preceded by P waves, but the PR intervals differ. This indicates that the escape rhythm has changed to a different focus and is not conducted.

Mobitz II AV block requires at least 2 consecutively conducted P waves before the block occurs, which is clearly not the case here (Figure 1).

Isorhythmic AV dissociation only occurs when the atrial and ventricular rates are very close (Figure 2).

The criteria for complete heart block are met:

- More P waves than QRS complexes.
- AV dissociation.
- Slow ventricular escape rhythm (usually regular).

The correct answer is therefore (a): Complete heart block.

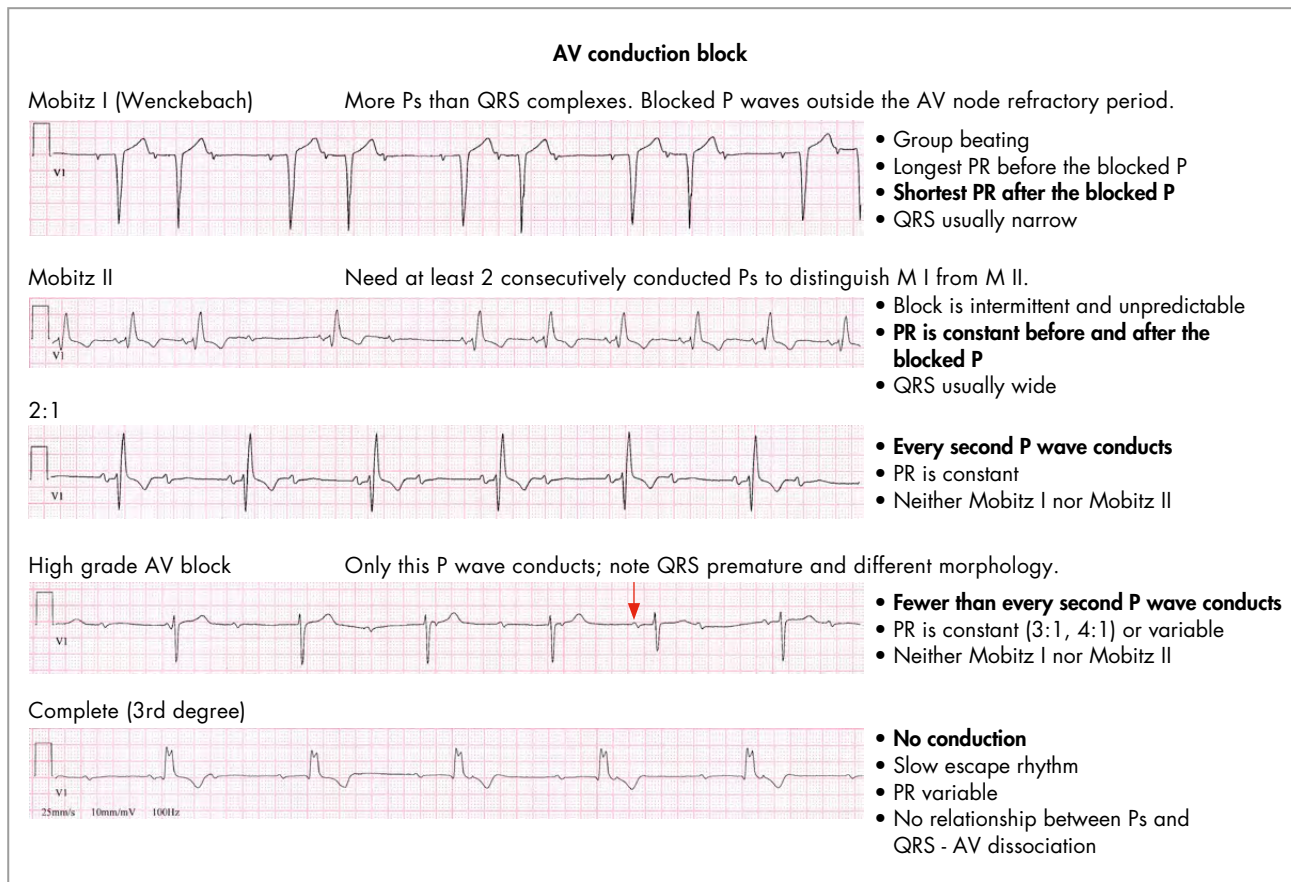


FIGURE 1: AV Conduction Block.

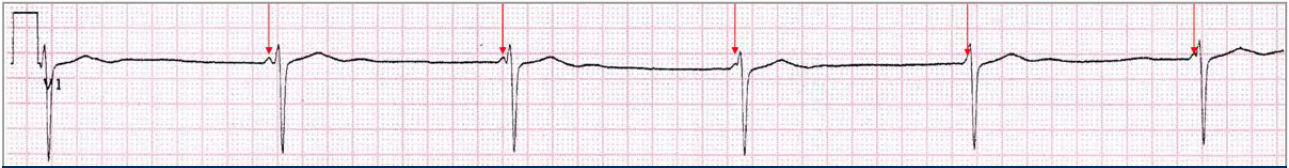


FIGURE 2: Isorhythmic AV dissociation.

2. SHE IS BEING MONITORED IN ICU; WOULD YOU INSERT A TEMPORARY PACING LEAD?

Temporary pacing leads have potential complications and are better avoided, if possible.

However, there are features of this ECG which strongly suggest that she should have a temporary pacing lead inserted, even though she has not had syncope. The sinus tachycardia of 106/min indicates that the heart is under stress and there has been catecholamine activation.

The last 2 complexes differ in morphology to those preceding and are slightly faster, indicating a change in the escape rhythm focus. An unstable escape rhythm indicates a risk of asystole (Figure 3).

The markedly prolonged QT interval is a strong reason to start temporary pacing without delay. A QT over about 600ms indicates a high likelihood of developing torsade de pointes ventricular tachycardia which can quickly degenerate into ventricular fibrillation or be followed by ventricular asystole. The pacing wire can be inserted via the femoral vein, where it will

not interfere with the permanent pacemaker implantation, which should be done as soon as possible.

A temporary pacer had not been instituted and she developed a run of torsade de pointes, followed by asystole (Figure 4). Fortunately, an escape rhythm kicked in.

Increasing the heart rate by pacing will shorten the QT and reduce the dispersion of depolarisation that precipitates this arrhythmia (Figure 5) and removes the risk of asystole.

The answer is (a): Yes.

DISCUSSION

Complete heart block is a lethal arrhythmia (Figure 6) and is an indication for urgent admission to a centre where a permanent pacemaker can be inserted. Exceptions include conditions in which the AV block is reversible, e.g. acute inferior wall myocardial infarction.

We don't know how many people die with their first Stokes-Adams attack. A natural history study, published in 1964⁽¹⁾

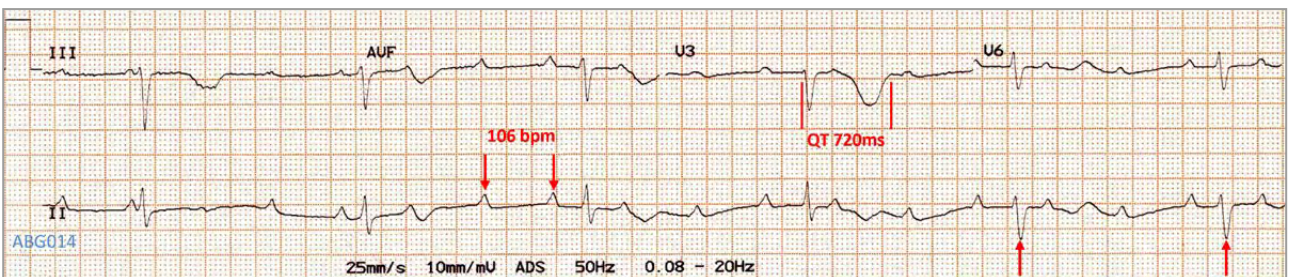


FIGURE 3: Sinus tachycardia, prolonged QT interval and change in escape focus.

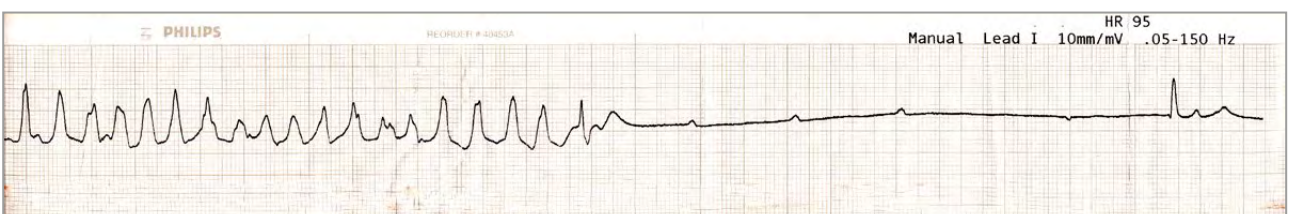


FIGURE 4: Torsade de Pointes, followed by asystole.



FIGURE 5: Shortened QT after temporary pacing.

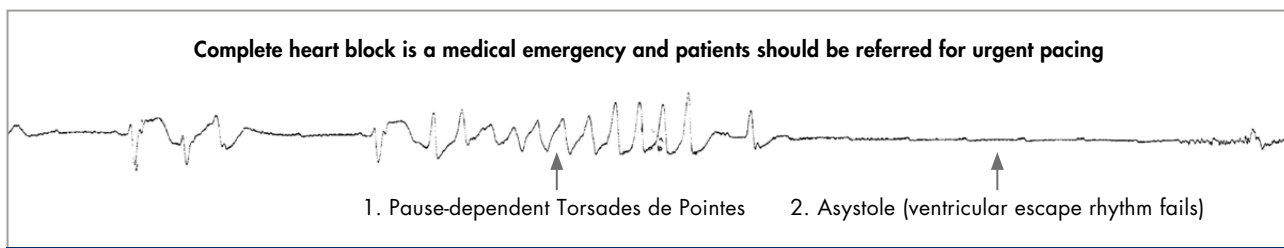


FIGURE 6: Mechanisms of death in complete heart block.

followed 100 patients for up to 5 years. Fifty percent died within a year, but only 37 were known to be alive (Figure 7). The fall off was slower after that but only 20 were known to be alive at 5 years. Five studies, including one from Johannesburg, of patients with early pacemakers (mostly VOO), showed 1 year survival of 80% -90% and 5 year survival of 60% - 70%. The study by Monty Zion, Paul Marchand and Pro Obel⁽²⁾ compared the survival to an age-matched insured population and showed no significant difference in survival between the

paced patients and the controls. There are few interventions in medicine that compare with this dramatic improvement, both in longevity and relief of symptoms. The artificial cardiac pacemaker has been acknowledged as one of the great inventions of the 20th century.

Most patients who develop heart block are over the age of 65. In most cases, no cause is evident. Idiopathic age-related degeneration of the conducting system is the most likely pathology

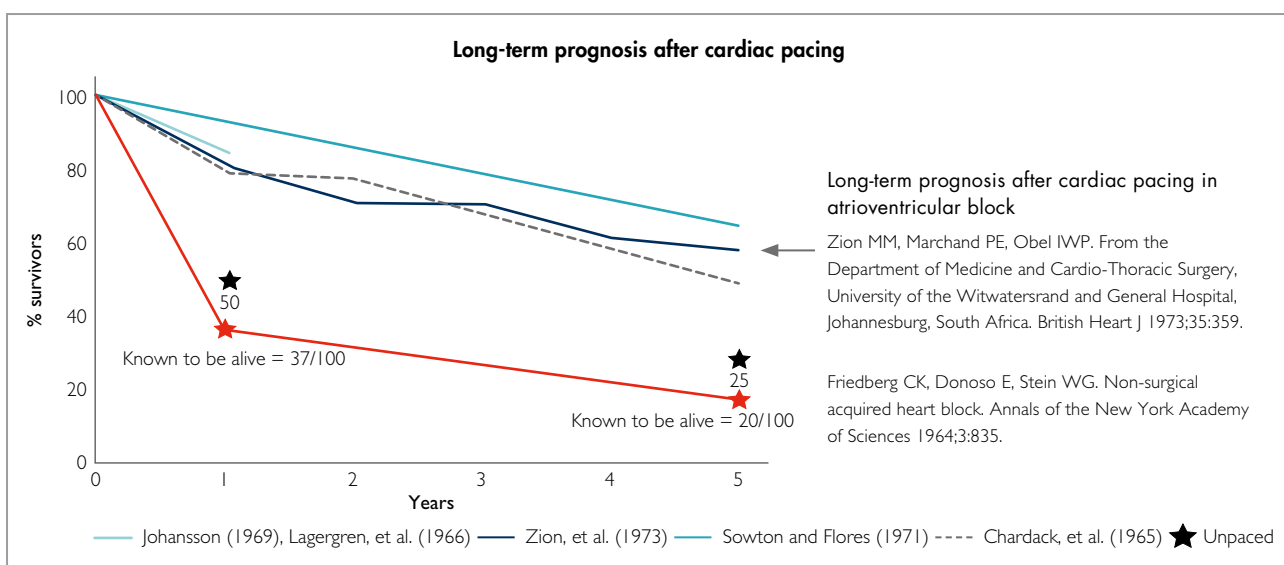


FIGURE 7: Effect of pacing on long term prognosis.

FIGURE 7: Survival curves in this and in previously reported series, compared with the natural history for atrioventricular block.

(Lenegre's disease). They will often be otherwise fit and well for their age and will benefit from pacing, even into their 90s. However, heart block can occur at any age from in utero onwards. Consider the long list of conditions that can cause heart block (Table I) and perform the necessary investigations, particularly in younger patients. Some cases, such as AV block complicating acute inferior wall STEMI, are reversible and permanent pacing may not be necessary.

If a patient presents with a heart rate under 40/min, an ECG is obviously necessary for a definitive diagnosis. However, clinical signs of AV dissociation will point to the diagnosis:

- A regular, slow pulse but varying pulse volume.
- Irregular canon waves in the jugular venous pulse.
- Varying intensity of the first heart sound.

In an older person, the pulse pressure tends to be high. A typical BP would be 170/70mmHg. Left ventricular function is usually normal and compensates for the slow rate by increasing stroke volume. This higher stroke volume is being ejected into a non-compliant arterial tree, causing a high systolic pressure. Lack of elastic recoil and long diastolic time contribute to a

lower diastolic pressure. If the BP is low, suspect an acute cause, such as myocardial infarction or myocarditis.

A patient who develops heart block in South Africa has to have access to a doctor who will do an ECG and recognise the condition and act appropriately by referring him or her directly and urgently to a practitioner or hospital that can implant a pacemaker. A survey of GP's ability to recognise important arrhythmias showed that only 1% were able to diagnose complete heart block.⁽³⁾ This is a shocking statistic, given the seriousness of the condition and the effectiveness of treatment. Prof Chin tells me that they are still getting referrals of patients with heart block to Groote Schuur hospital, correctly diagnosed, to an outpatient clinic instead of to the emergency room for urgent admission.

Access to diagnosis and treatment, particularly in rural areas, is poor. It is reflected in the unequal distribution of pacemaker implants in White vs. Black South Africans.⁽⁴⁾ More recent comparisons are not available, but the 2001 survey of cardiac pacing in South Africa showed large discrepancies in implant rates between the insured (mostly White) with the uninsured (mostly Black) population, with a ratio around 8.5:1.⁽⁴⁾ Implant

TABLE I: Causes of heart block

<p>Older age The risk increases with advancing age, due to idiopathic age-related degeneration of the conducting system. These are the majority of cases.</p>	<p>Chronic infiltrative / inflammatory myocardial disease</p> <ul style="list-style-type: none"> • Sarcoidosis • Other granulomas (e.g. Wegener's) • Amyloid • Connective tissue disorders • Tuberculosis • Chaga's disease (South America)
<p>Idiopathic Can occur at any age. Some of these cases are probably due to undiagnosed infiltrative conditions, such as sarcoidosis.</p>	<p>Aortitis</p> <ul style="list-style-type: none"> • Ankylosing spondylitis • Syphilis
<p>Acute myocardial damage Infarction. Second or third degree AV block is most common after inferior ST elevation myocardial infarction (STEMI). This is usually transient, especially after successful reperfusion, and does not require a permanent pacemaker. AV block after anterior STEMI is more serious. It tends to occur with large infarcts destroying the interventricular septum. Survivors should be paced.</p> <p>Myocarditis</p> <ul style="list-style-type: none"> • Heart block is common in myocarditis from a variety of causes – viral, Lyme disease, typhoid, and others <p>Trauma (e.g. stab)</p>	<p>Genetic</p> <ul style="list-style-type: none"> • Muscular dystrophies <ul style="list-style-type: none"> - Kearns-Sayers - Myotonic dystrophy • Inherited conduction disease <ul style="list-style-type: none"> - E.g. Progressive familial heart block
<p>Chronic myocardial disease</p> <ul style="list-style-type: none"> • Ischaemic • Cardiomyopathy 	<p>Drugs (usually in overdose or combination)</p> <ul style="list-style-type: none"> • Digoxin • Calcium channel blockers • Beta blockers – usually in combination with digoxin or calcium blocker • Sodium channel blockers – e.g. Class II antiarrhythmics, antidepressants
<p>Post surgical</p> <ul style="list-style-type: none"> • Valve repair / replacement • Following surgery for congenital heart disease • Following trans-cutaneous aortic valve implantation 	<p>Other</p> <ul style="list-style-type: none"> • Hyperkalaemia – usually causes sinus slowing, PR prolongation and P wave flattening, but may cause complete heart block • Hyperthyroidism is a rare cause of heart block, usually precipitated by an intercurrent infection
<p>Infective endocarditis</p>	

rates among Whites approximated the average in Europe. This may be partly explained by the relative youth of the Black population, but it is unlikely to account for so large a difference. Heart block accounted for more than 80% of implants in the public sector, as opposed to 45% in the private sector, typical of a resource poor environment. While there is likely to be shift over the last 23 years with growth in the number of insured Black people, there is no reason to believe that this life-saving treatment has become more accessible to indigent, mostly rural people, given the poor state of peripheral health services, many of which do not even have an ECG machine. The overall implant rate has, however, increased significantly from 39/m in 1998⁽⁵⁾ to 132/m in 2013.⁽⁶⁾

The situation is even worse in the rest of sub-Saharan Africa, with only a few countries providing pacemakers, usually only in the private sector. Attempts are being made to improve this, by providing training in pacemaker implantation in South Africa to doctors from other African countries, and trying to secure donations of resterilised explanted units for indigent patients.

LESSONS AND CONCLUSIONS

- **A heart rate below 40/min is heart block until proven otherwise** – 40 to 50 is suspicious.
 - A bradycardia in which there are more P waves than QRS complexes = heart block.
 - Heart block + AV dissociation (no relationship of Ps to QRS complexes) = complete heart block.
 - The escape rhythm is usually wide (ventricular) and regular but may be narrow (junctional).

- Escape rhythms are often unreliable, as in the case presented.
- A QT interval over 600ms increases the risk of torsade de pointes, which may degenerate into VF.
- The mechanism of syncope is either torsade de pointes or asystole.
- The mechanism of sudden death is either ventricular fibrillation or asystole.

- **Heart block is a medical emergency.** Refer urgently for pacing, even if asymptomatic.
- **Pacemakers save lives.**

Conflict of interest: none declared.

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