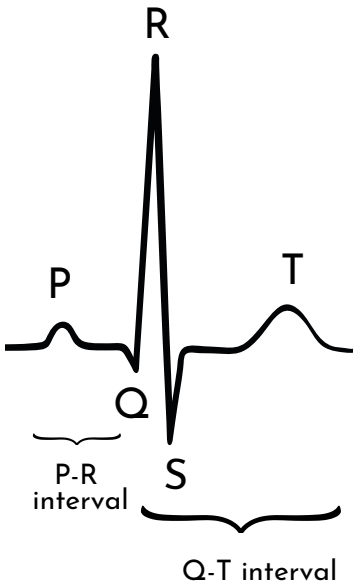
Vet Helpful Notes

ECG Interpretation Work Book



Vocabulary

P wave: depolarization/contraction of the atria

R wave: (QRS complex) Ventricular depolarization and contraction

T wave: repolarization of the ventricles

Sinus: originating from the SA node

Supraventricular: coming from above the AV node, the QRS has a normal shape

Ventricular: coming from the ventricle, the QRS has an abnormal shape and is "wide and bizarre"

Premature: occurring early

Paroxysmal: sudden and occasional

Escape: occurring after a delay

Conduction starts at the SA node in the right atrium and propagates to the AV node, down through the bundle of His, and finally to the Purkinje fibers of the Ventricles.

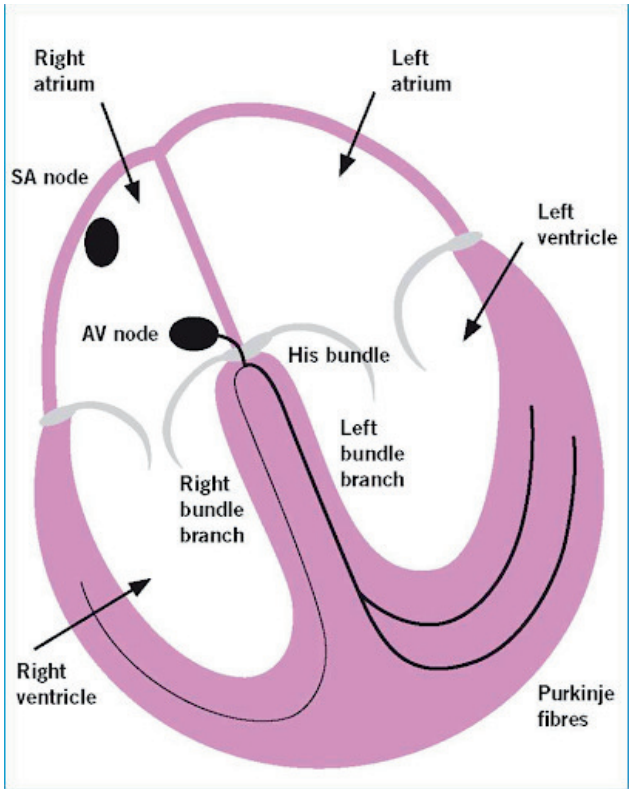
Partial or complete blockage of electrical activity at the AV node is a form of AV Block (Types 1-3).

Junctional escape beats are started at the AV node or bundle of His.

Premature ventricular complexes occur from various locations in the ventricles.

A ventricular escape rhythm usually 30-50 bpm in dogs and 60-100 in cats

Junctional escape rhythms are faster in dogs, usually 60-80 bpm

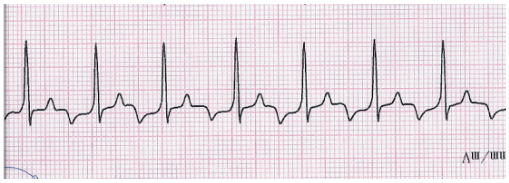


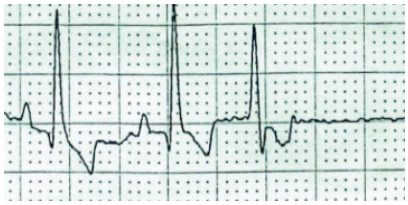
ECG questions to ask:

Is there a p for every QRS and a QRS for every p wave?
For example, in Type II and III AV Block you will not have a QRS for every p wave

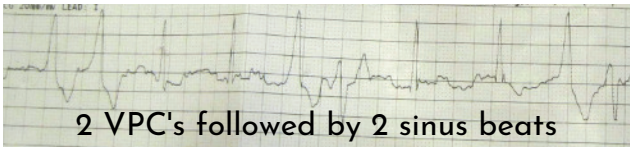


Is the rhythm regular or irregular?
For example, a sinus tachycardia that is beating very regularly. All beats may be spaced apart regularly.

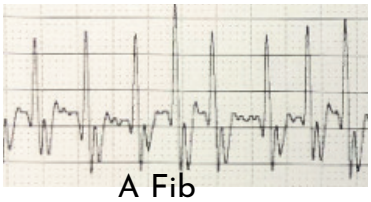




If the rhythm is irregular, is it regularly irregular or irregularly irregular?
For example, you can have an irregular rhythm with VPC's happening close together, but occurring at regular intervals- such as in bigeminy.
An example of an irregularly irregular ECG rhythm is atrial fibrillation



2 VPC's followed by 2 sinus beats



A Fib

Is the rhythm too fast or too slow?
Too fast = tachycardia Too slow = bradycardia
A very common cause of bradycardia is elevated vagal tone or 3rd degree AV Block



V Tach



Slow rhythm. 3rd Deg AV block

Do the QRS complexes look narrow or large, wide and bizarre?
Narrow QRS complexes originate from above the ventricles.
Wide an bizarre complexes originate from the ventricles.



although these look narrow here, when you see the other type of complex, you know these are actually wide and bizzarre and much bigger. Therefore, they are ventricular.

normal sinus beats. They are narrow and smaller than the other wave forms

Evaluating Common Arrhythmias





Normal Heart rate

Narrow QRS

- Regular rhythm
  - Normal sinus rhythm
- Iregular rhythm
  - Normal sinus arrhythmia
  - 1st or 2nd deg AV Block

Wide QRS

- Regular rhythm
  - Accelerated idioventricular rhythm
  - RBB or LBB sinus rhythm

Increased Heart rate

Narrow QRS

- Regular rhythm
  - Sinus Tachycardia
  - Supraventricular Tachycardia (SVT)
  - Atrial flutter
- Iregular rhythm
  - Atrial fibrillation

Wide QRS

- Regular rhythm
  - Ventricular Tachycardia (VTach)
  - RBB or LBB sinus tachycardia

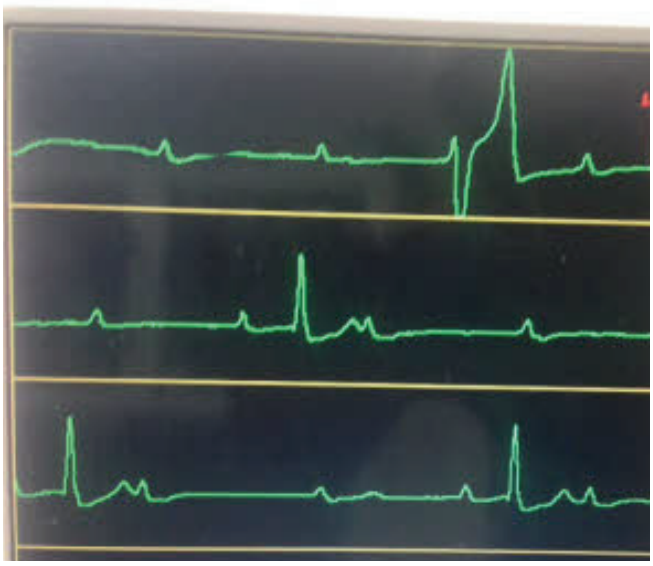
Slow Heart rate

Narrow QRS

- Regular rhythm
  - Sinus bradycardia
  - Junctional escape rhythm

Wide QRS

- Regular rhythm
  - Ventricular Escape Rhythm



If you have a patient under anesthesia and see this come up on your monitor. The rhythm is very SLOW.

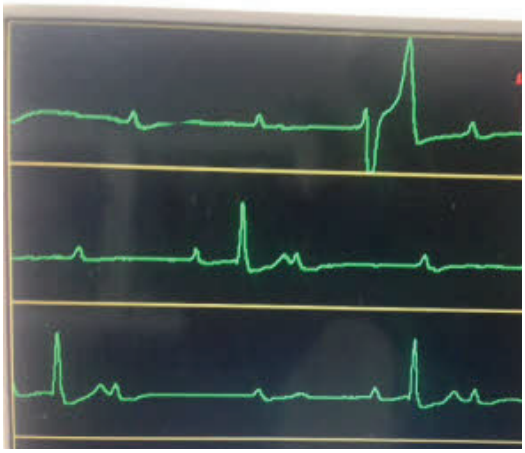
- Is there a p wave for every QRS?

- Is there a QRS for every p wave?

- Do the p waves seem associated or disassociated from the QRS complexes?

- What is this rhythm?

- What is the treatment for this rhythm?



If you have a patient under anesthesia and see this come up on your monitor.
The rhythm is very SLOW.

- **Is there a p wave for every QRS?** NO
- **Is there a QRS for every p wave?** NO
- **Do the p waves seem associated or disassociated from the QRS complexes?**

They seem disassociated from the QRS complexes. In other words, the p waves march along at a pretty regular rate, but irrespective of where the QRS complexes are showing up.

- **What is this rhythm?**

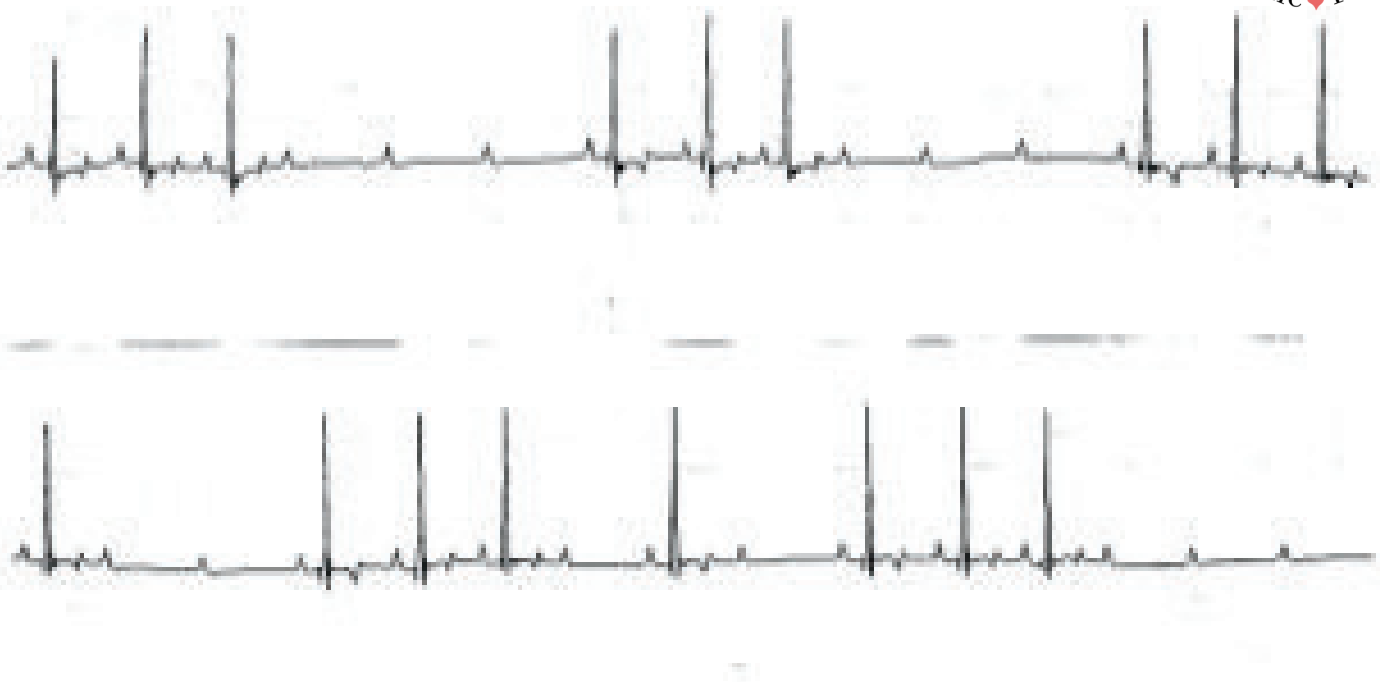
This is 3rd Degree AV Block
3rd degree AV block means there is no communication between the atria and the ventricles. So, the heart is basically contracting at a slow ventricular escape rate. The ventricular escape rate in dogs is very slow at 2-40 bpm. In cats, it's a little higher at 60-80 bpm and sometimes higher.

FACT dogs with 3rd degree block will often have syncope (fainting spells)
But, cats, being cats--- are typically ASYMPTOMATIC. That is presumed to be because of the intrinsically higher HR set by the ventricular pacemaker (bundle of HIS) and because of their sedentary nature.

If you hear a very slow heart rate, even without an arrhythmia, you might want to check an ECG just to see.

- **What is the treatment for this rhythm?**

The treatment for 3rd degree AV block is a pacemaker. A pacemaker is an implanted device that consists of a small generator implanted under the skin and is attached to a pacing lead that travels to the ventricle and is embedded there. The pacemaker can sense if the heart is firing at a correct rate. It steps in to trigger a heartbeat if there is too long of a delay.

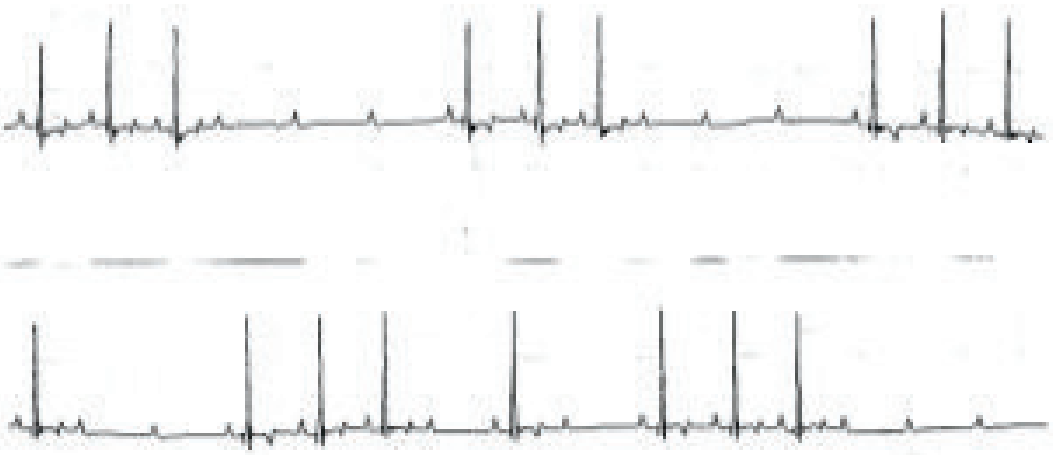


Is there a p wave for every QRS?

Is there a QRS for every p wave?

What is this rhythm?

What is Vagal Tone and how can this play a role in this arrhythmia?



Is there a p wave for every QRS?
YAH

Is there a QRS for every p wave?
Nope. In fact, there are multiple p waves without a QRS. This means, the electrical conduction from the atria is being blocked at the AV node before it can signal the ventricles to contract (and produce a QRS complex). P waves that produce a delayed QRS complex (ie an elongated P-R interval) is FIRST degree AV Block.

What is this rhythm? SECOND degree AV Block.
P waves that are sometimes blocked and there are NO associated QRS complexes is evidence of a SECOND degree AV Block. Second degree AV block might be benign. It can be associated with increased vagal tone. Sedation drugs can increase vagal tone for example. This why 2nd degree AV block can be seen in some sedated/anesthetized patients.

What is Vagal Tone? It is the parasympathetic enervation to the heart. The parasympathetic nervous system controls "REST and DIGEST". When there is increased vagal tone, it acts directly on the SA node (where the electrical activity of the heart starts). High vagal tone SLOWS down the heart rate (REST) and also has other effects on the body to promote a resting system (digestion etc.).

To check if the 2nd degree block is just due to high vagal tone, you can do an atropine response challenge. If you use atropine, it raises the heart rate and blocks the vagal tone to the heart. The 2nd degree block should resolve in this case.

P waves which NEVER communicate through the AV node and are NEVER associated with QRS complexes is THIRD degree AV Block. This is NOT GOOD. If you're basically relying on the last pacemaker in the ventricles to keep the heart beating. This ventricular escape rhythm is the slowest of the pacemakers (SA node is the original pacemaker, then there is a pacemaker in the AV node and the purkinge fibers of the ventricles.



This dog has a normal heart rate but this rhythm looks very funky/scary. I know the ECG looks blurry. Just squint and lemme know these answers!

Is this rhythm regular or irregular? (not the wave forms, are the wave forms happening in a regular or irregular fashion?)

Is there a p wave for every QRS? Is there a QRS for every p wave?

Can you guess the rhythm diagnosis?



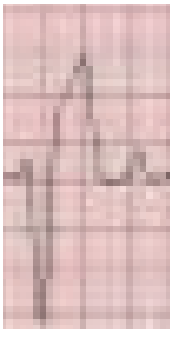
This dog has a normal heart rate but this rhythm looks very funky/scary. I know the ECG looks blurry. Just squint and lemme know these answers!

Is this rhythm regular or irregular? (not the wave forms, are the wave forms happening in a regular or irregular fashion?)
This looks like a regular rhythm

Is there a p wave for every QRS? Is there a QRS for every p wave?
YAH all around

Can you guess the rhythm diagnosis?
This is a RIGHT BUNDLE BRANCH BLOCK. The QRS complexes are wide and bizarre. But what's in front of every QRS? A P WAVE. So, the p wave is initiating the electrical activity. It's just moving through the purkinje fibers in the right ventricle very slowly, compared the the left ventricle. This wide bizarre complex looks sort of like an "M" with a prominent downward deflection.

What treatment is needed?
RBB are generally considered benign. No treatment is needed.
LBB is a concerning arrhythmia.



"William Morrow"



LBB:WiLLiam looks like an W in V1

RBB: MoRRow looks like an M in V1



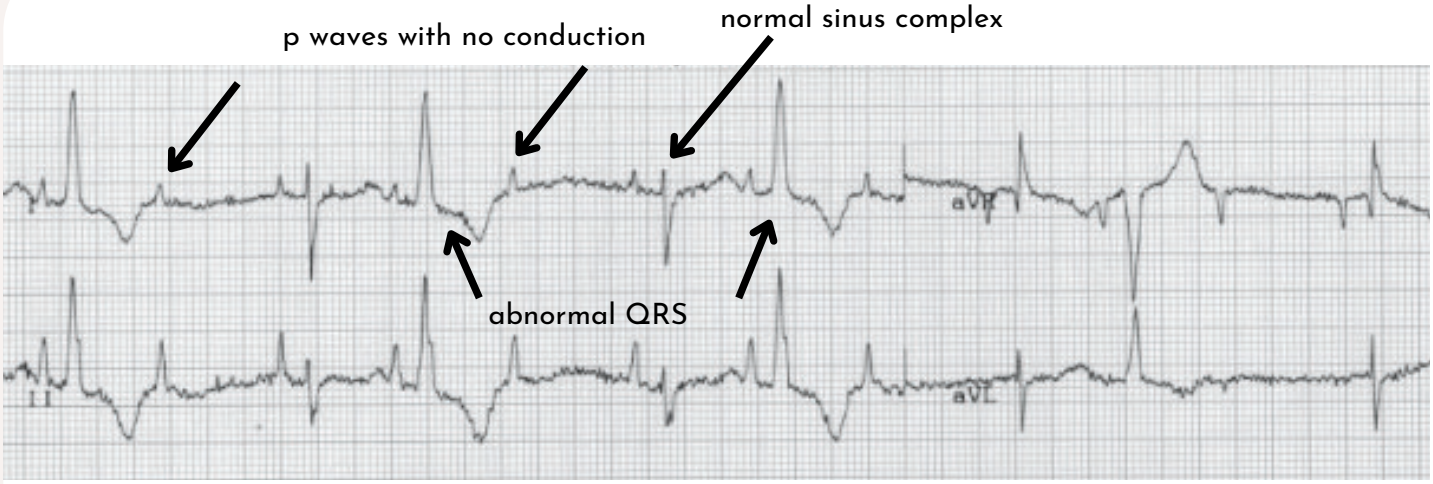


Point out the normal sinus complexes. Then point out the abnormal complexes.

Is there a p wave for every QRS?

Is there a QRS for every p wave?

Can you say what's going on in this strip?



ECG strip from a 16 yo cat

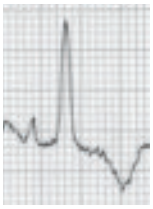
Point out the normal sinus complexes. Then point out the abnormal complexes.

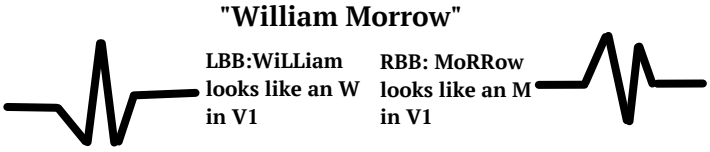
Is there a p wave for every QRS? YAH

Is there a QRS for every p wave. Not always. That's 2nd degree block

Can you say what's going on in this strip?

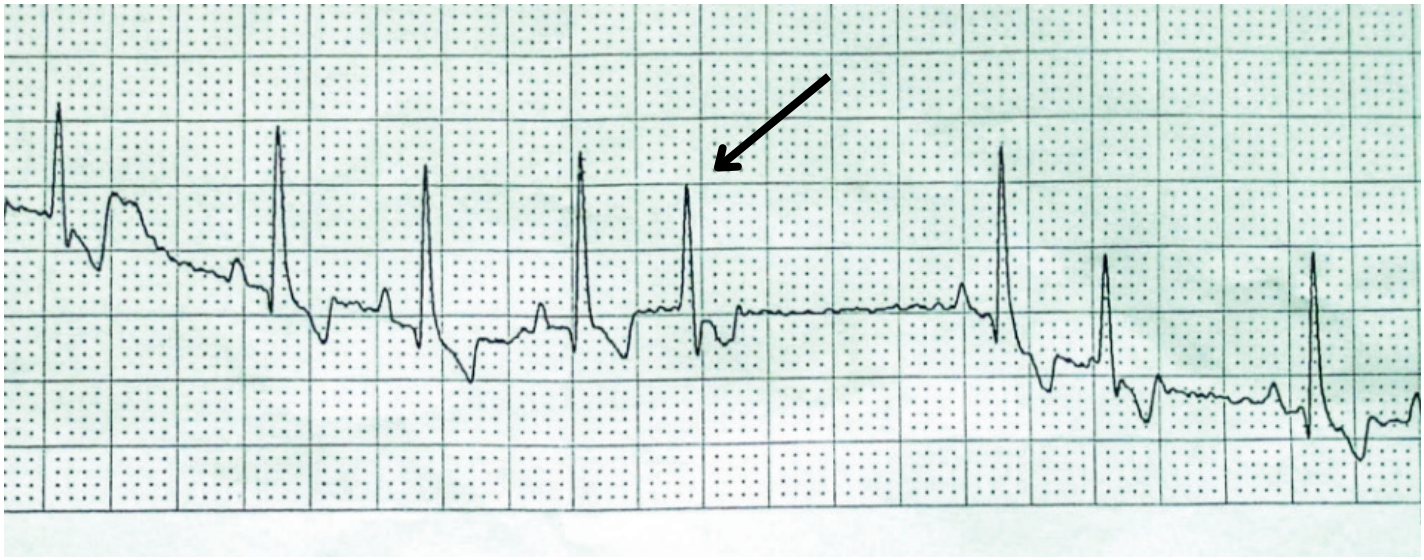
Because there IS a p wave in front of the ventricular looking beat, that means this is a bundle branch block. BUT, this is a LEFT bundle branch block. A LBB looks more like a W with a tall middle deflection.
A LBB is delayed conduction through the purkinje fibers of the left ventricle. There's also some 2nd degree AV Block.







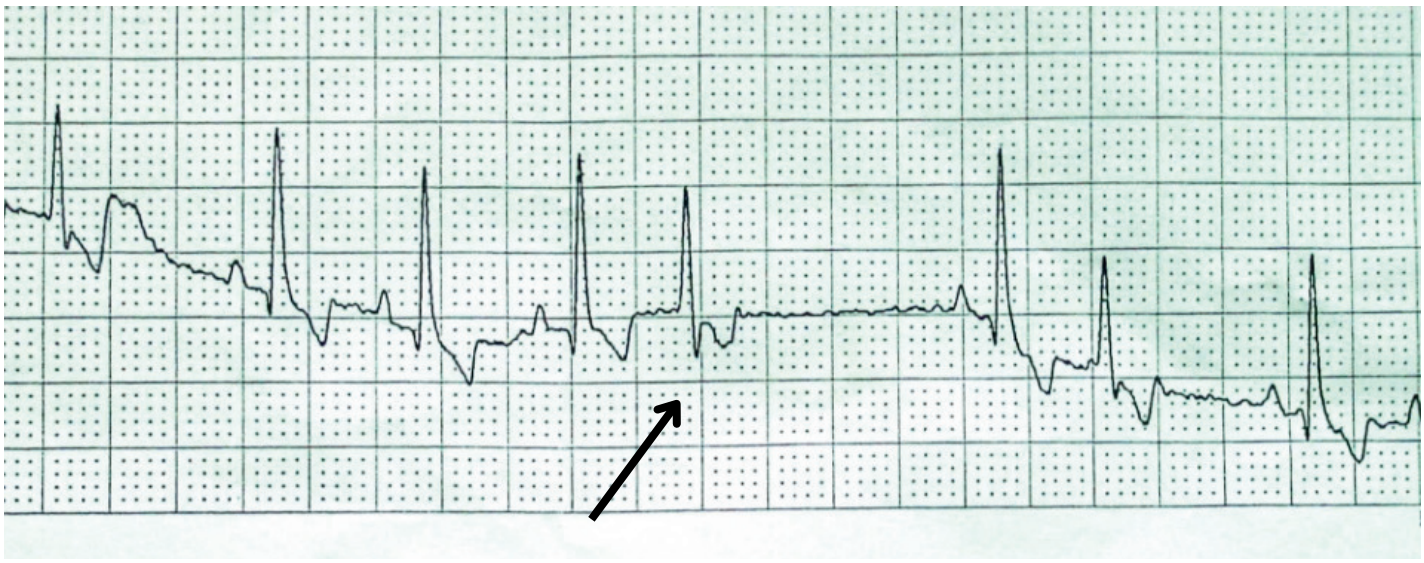
So this ECG shows 2nd degree AV block AND a left bundle branch block. The rate of firing of the p waves is 200 bpm, so an atropine challenge is NOT necessary. (This is not 2nd degree block due to high vagal tone). There is likely degenerative disease of the heart's electrical conduction system. If it deteriorates further, a pacemaker might be needed.



What type of complex is the arrow pointing towards?

Is there a p wave for every QRS? A QRS for every p wave?

Is this beat occurring prematurely?



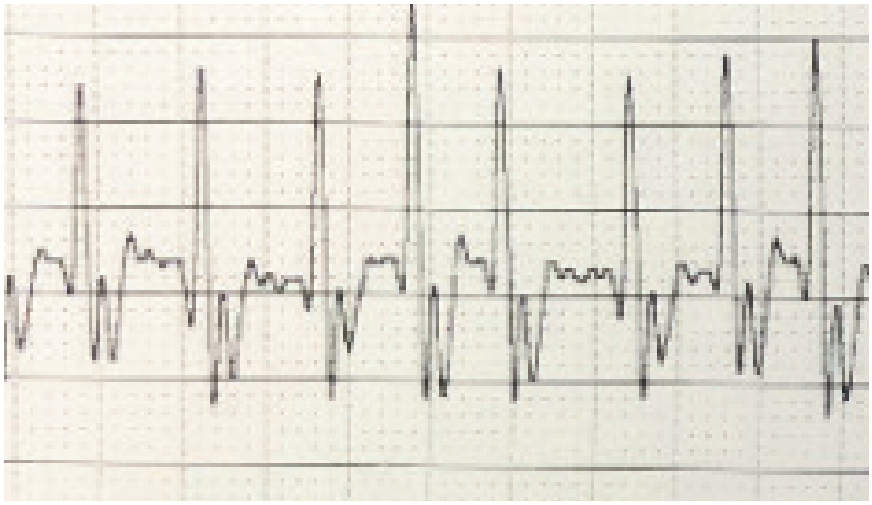
What type of complex is the arrow pointing towards?

A junctional premature beat (or a beat arising from the AV node). There is no p wave, but the complex looks supraventricular.

An atrial premature contraction looks like a normal sinus beat, but the p wave is unusual- it can be taller, upside down or wider . Because this looks like a normal supraventricular beat, but has no p wave , we know it's not derived from the atria. It's also not wide and bizarre which would mean its not derived from the ventricles. It's just at the junction between the atria and the ventricles. There is a QRS for every p wave, but not a p wave for every QRS.

This beat is premature (you can see it pops up too close to the last complex compared to the normal sinus beats). It is occurring in a 9 year old SF boxer with an enlarged left atrium.

This stretched out atrium is leading to some abnormal electrical activity.



Is the rhythm regular or irregular?

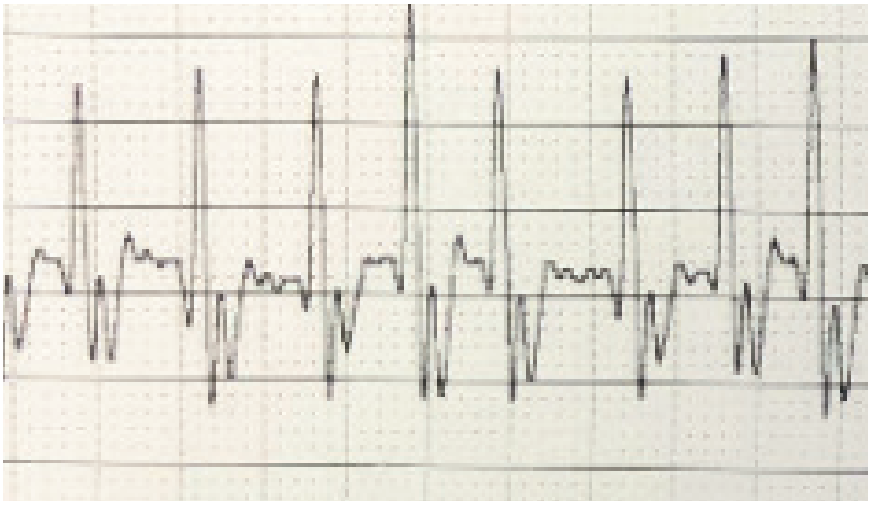
If the rhythm is irregular is it regularly irregular? Or is it irregularly irregular?

Do you see p -waves for every QRS?

Can you name this rhythm?

HINT: This is a fast HR. The patient has an audible arrhythmia that sounds like "shoes in the dryer".

How do you treat this rhythm? What is a common disease that causes this rhythm?



Is the rhythm regular or irregular?
The R-R interval varies, so the rhythm is irregular

If the rhythm is irregular is it regularly irregular? Or is it irregularly irregular?
It is irregularly irregular

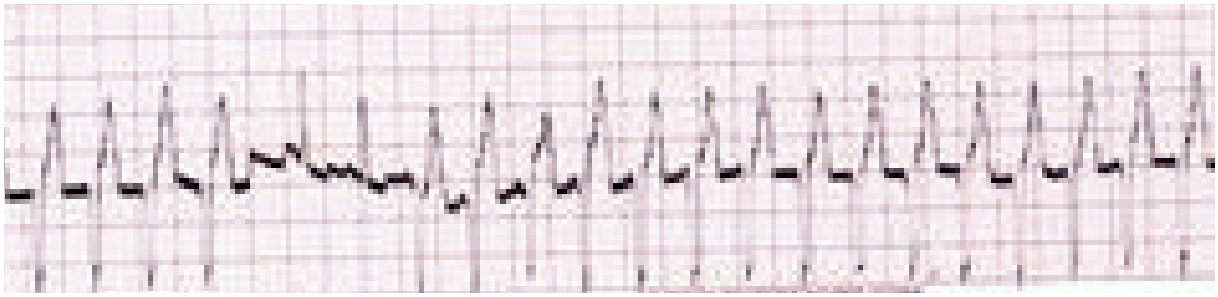
Do you see p -waves for every QRS? It's hard to distinguish the p waves clearly- the baseline looks bumpy

Can you name this rhythm?
This is atrial fibrillation

HINT: This is a fast HR. The patient has an audible arrhythmia that sounds like "shoes in the dryer".

How do you treat this rhythm? What is a common disease that causes this rhythm?

You treat A fib by slowing down the HR with betablockers, diltiazem or digoxin.
Dilated cardiomyopathy is a common condition that causes A fib because the conduction is altered when the heart wall muscle becomes stretched and thin.

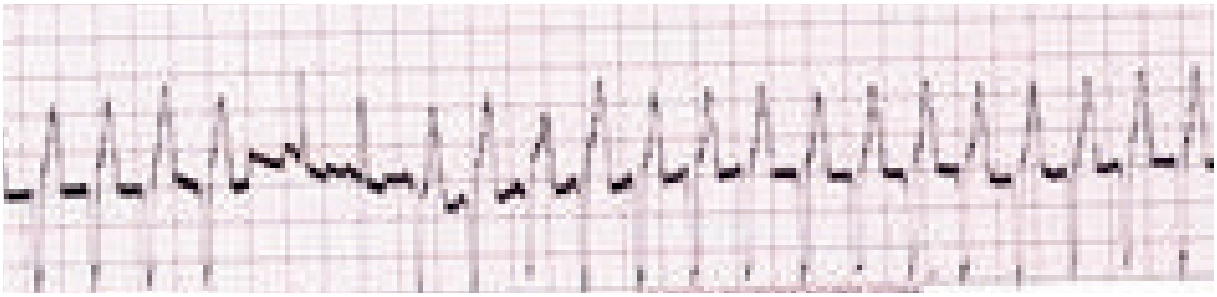


Sorry you have to squint on this one. But, you can tell right away there are two types of rhythms here. This is a very fast rhythm.

What are the two smaller complexes? Do they originate from the atria or the ventricles?

What are the rest of the complexes? Do they originate from the atria or the ventricles?

What rhythm is this? Do you need to treat this rhythm? If so, how?
HINT: they are very fast. The patient has evidence of poor perfusion: low BP, pallor.



Sorry you have to squint on this one. But, you can tell right away there are two types of rhythms here. This is a very fast rhythm.

What are the two smaller complexes? Do they originate from the atria or the ventricles?

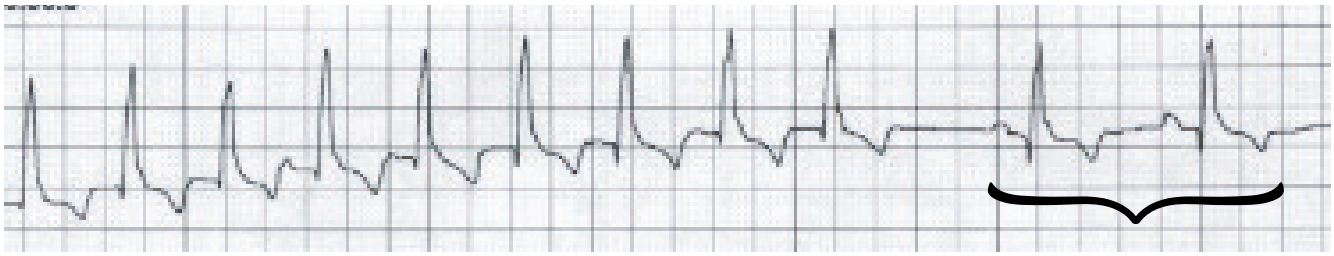
These two complexes are sinus beats that originate from the atria.

What are the rest of the complexes? Do they originate from the atria or the ventricles?

The rest of the complexes are ventricular in origin, premature ventricular beats.

What rhythm is this? Do you need to treat this rhythm? If so, how?
HINT: they are very fast. The patient has evidence of poor perfusion: low BP, pallor.

Yes, rhythm is V tach (ventricular tachycardia). The rhythm broke for a couple of beats and you can see the normal sinus complexes. It went right into V Tach again. The treatment of choice is IV lidocaine.

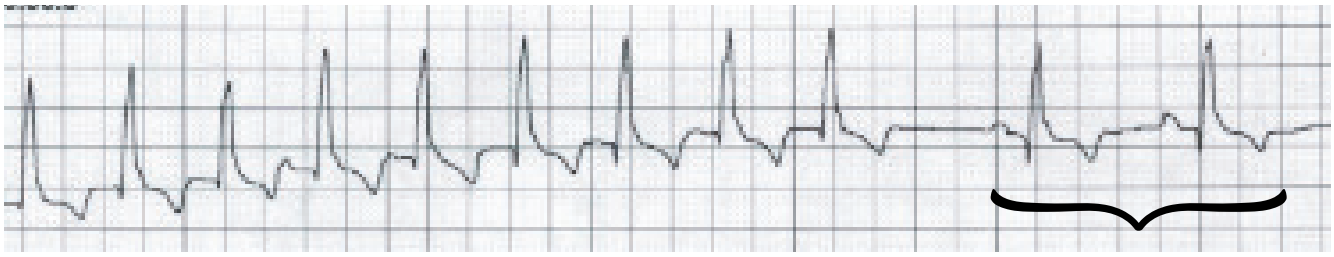


If this is a normal sinus rhythm (NSR), what is the run of complexes preceding the NSR here?

HINT:
Is the rhythm faster or slower than the NSR?

Can you make out p waves before every QRS?

Are the complexes originating from the atria or the ventricles?



If this is a normal sinus rhythm, what is the run of complexes preceding the NSR here?

HINT:
Is the rhythm faster or slower than the NSR?

This rhythm is faster than the sinus beats following this run of beats. The R-R interval preceding the NSR is smaller, therefore the rhythm is faster. It is SVT (supraventricular tachycardia)

Can you make out p waves before every QRS?

It's hard to see the p waves before every complex. In fact, the t waves almost look like they could be a p wave in the faster set of sinus beats.

Are the complexes originating from the atria or the ventricles? These are originating from the atria. They have a similar size/shape as the sinus beats.

This rhythm diagnosis is a run of supraventricular tachycardia. It starts and then abruptly stops. It would be a good idea to place a Holter monitor to continuously evaluate an ECG tracing to see how many times in a day there are runs of SVT. If there are a lot of episodes, then diltiazem would be a good choice to treat this patient.



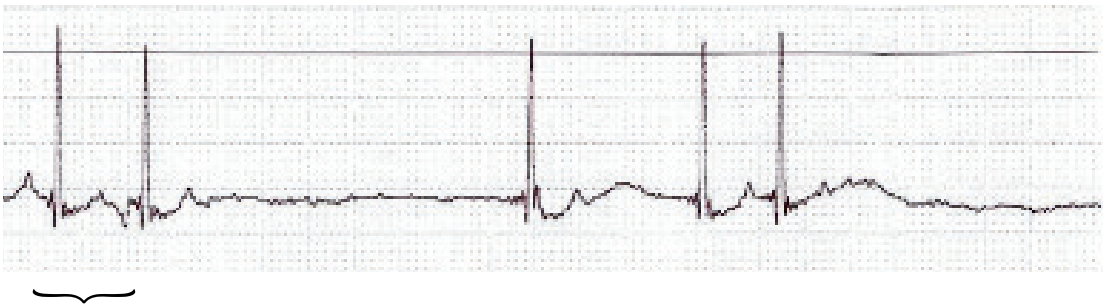
Two normal sinus beats followed by a LONG pause

What are the two beats that occur right after the long pause?

IE, where do they originate from? At the atria or the ventricles?

What's missing from the complex? Is the rate of these two beats faster or slower than the two preceding normal beats?

What is the diagnosis? HINT this is a Schnauzer.



Two normal sinus beats followed by a LONG pause

What are the two beats that occur right after the long pause?
These are junctional escape beats. They look like a supraventricular beat without a p wave.

IE, where do they originate from? At the atria or the ventricles?
These originate in between the atria and the ventricles, at the junction. They are "junctional beats".

What's missing from the complex? Is the rate of these two beats faster or slower than the two preceding normal beats?

What's missing is the p wave. The rate is slower between the two junctional beats sandwiched between the normal sinus beats. This is because they are junctional "escape" beats that arise from the AV node of the bundle of His. They take over to initiate a beat when there has been too long a delay from the SA node. Their rate of firing is slower than the AV node but faster than a ventricular escape rhythm.

What is the diagnosis? HINT this is a Schnauzer.

This is Sick Sinus Syndrome. It is characterized by a "brady-tachy" (slow-fast) tracing. You see long pauses and then initiation of the rhythm by the junctional escape complexes. Following these two junctional escape beats are spurts of normal or premature atrial beats. These dogs eventually develop clinical symptoms of exercise intolerance, lethargy and syncope (fainting). Ultimately a pacemaker will be recommended for this patient.



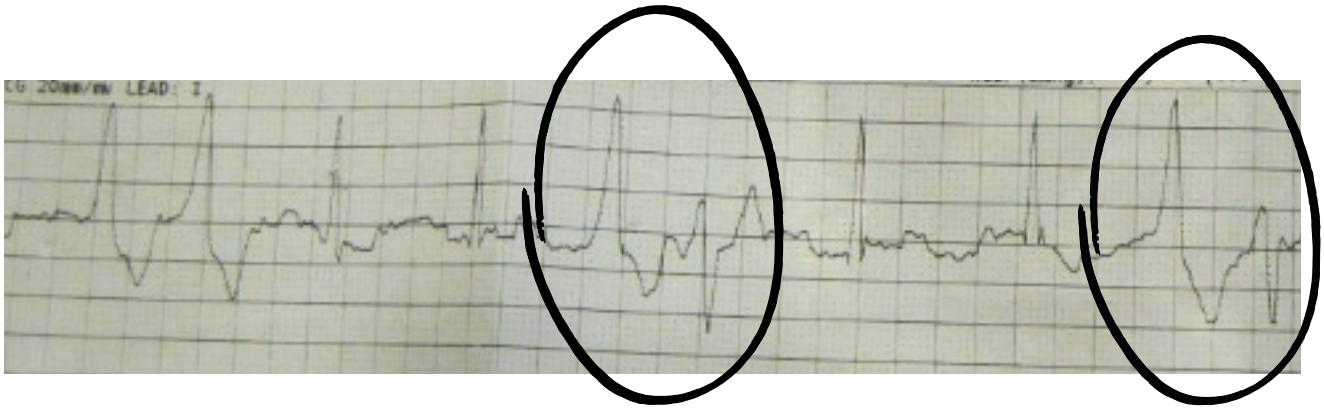
What types of complexes are happening between the circled beats?

Are they ventricular or supraventricular?

What do the paired circled complexes look like? Are they ventricular or supraventricular?

Do the two complexes that are within each circle look the same or different than each other?

Do you know the name for these paired beats that look different from each other but occur repeatedly?



What types of complexes are happening between the circled beats?
In between the circled beats are normal sinus complexes.

Are the circled beats ventricular or supraventricular?
The circled beats are both ventricular. They look wide and bizarre compared to the normal sinus beats. This rhythm strip is showing multifocal VPC's. These are VPC's that look different. (ie one big and one smaller VPC in this case).

Do the two complexes that are within each circle look the same or different than each other?

They look different than each other.

Do you know the name for these paired beats that look different from each other but occur repeatedly at regular intervals?

This is called bigeminy. ("Bi" means two). There is one normal beat followed by an abnormal beat. In this case there is a normal beat followed by a pair of VPC's. Multifocal VPC's mean that there are VPCs that arise from different parts of the ventricle and therefore look different from each other. Multifocal VPC's indicate a more concerning arrhythmia is present. Investigation and treatment is warranted.

Hi! I'm Nicole!
I'm an ABVP diplomat (canine/feline) and a veterinarian for 20 years.

My passion is helping fellow vet professionals enjoy learning with fun, colorful and concise study guides.



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vethelpfulnotes@gmail.com