The ECG in Practice:
The Technician Doing ECG's and Interpreting an ECG

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ECG procedure

The electrocardiogram (ECG, EKG) is an important tool (Figure 1 illustrates common examples). This technique does not require any sedation or anesthesia, is non invasive, and once the basics are understood, interpretation is straightforward in most cases. If a challenging strip defies interpretation, specialists may be engaged by trans-telephony to assist with interpretation if a good physical examination, database, and history are available. Laboratory results are also important to have in hand before interpretation, as clues may be gleaned from such studies that help to narrow interpretation. If a pleural or abdominal effusion is present, those are tested and thoracic radiographs (at least two views) are also desirable as a concurrent test.

A diagnosis results when the interpretation includes physiologic changes, etiology and obvious alterations in anatomic features, cardiac and blood pressure status and assignment of prognosis.

The procedure consists of the capture of the electric fields generated by the pumping heart. Waveforms are just the recording of the electrical activity of the heart. Depolarization and repolarization generate these recordable changes. The concept of a lead is important to understand. Each lead gives us a little more information about the heart, but lead II is the basic lead from which we start our analysis. Each lead is a single plane of measurement of the function of the electrical activity of the heart. By setting up a positive and negative surface electrode setting, we may see the energy paths and analyze them. If energy is traveling away from the positive electrode, a negative orientation of the wave will occur, and if the net direction of the electrical energy impulse is towards the positive electrode, a positive deflection will occur. If the impulses are at perpendicular, an isoelectric deflection will occur.

Each cardiac cycle will initiate with an impulse which originates in the sinoatrial (SA) node. This node lives in the right atrium. An impulse will travel through the myocardium of the atria, resulting in depolarization. This is the event which generates the P wave on the tracing. When the atrium contracts, that is the time of the tracing record not the original SA node fire because this latter event is too small and does not trigger a recordable event

As the impulse moves through the atrioventricular (AV) node, which is near the base of the right atrium, the P-R interval is generated.

Conduction is a bit slow to travel to the ventricles so this is why we see the flat section—of course from a pathophysiology perspective, this means the atrium may finish contracting before the ventricles contract—a very important synchronization.

Once through the AV node, the conduction speed increases and the electrical activity fires through the bundle of His, the bundle branches, and also the Purkinje system.

Rapid, widespread depolarization of the ventricles then occurs. This leads to the QRS complex being recorded. Subsequent ventricle contraction then occurs.

The Q is the interventricular septum depolarization and so is the first negative deflection. The Q wave may not always be easy to isolate on the tracing.

The R portion is the ventricular myocardium depolarizing and the impulse travels from the endocardium to the epicardium. It is a positive deflection; also the most prominent waveform on the ECG.

The S wave is the basal ventricle posterior wall and interventricular septum activating. It is the first negative deflection following the R wave.

The repolarization of the ventricles is recorded as the T wave.

As repolarization is occurring, the ST segment is generated.

Indications

If one wishes to elucidate a cardiac arrhythmia or infer the status of the myocardium or the direct environment (as in pericardial effusion) then this test will be helpful. Tracings of the electrical activity of this organ may be affected by both physiologic or pathologic processes. Trying to isolate etiology, diagnosis and prognosis will lead us to use the test in situations such as:

1. Arrhythmias such as tachycardia, bradycardia
2. Presence of dyspnea, cyanosis, syncope or seizures
3. Shock or acute emergency or severe illness such as pyometra, GDV, uremia, pancreatitis, toxic insults
4. Electrolyte disturbances (especially potassium) or in the face of chronic diuretic administration
5. Peri-surgical monitoring (anesthetic agent toxicity, depth of anesthesia) or preoperative assessments in geriatric patients
6. Abnormal radiographic appearance of the heart or great vessels on radiographs—for example, chamber enlargement pattern (especially RV), with supportive diagnostics such as echocardiography
7. Murmurs

8. During diagnostic procedures such as pericardiocentesis
9. Routine health monitoring of senior or chronically ill patients where prognosis may be affected by the cardiac function
10. Pericarditis with low amplitude signatures
11. Elevations in vagal tone: nervous system, respiratory system, GIT system
12. Pharmacologic monitoring (for agents with known cardiotoxicity such as quinidine, digitalis, beta blockers)

Procedure

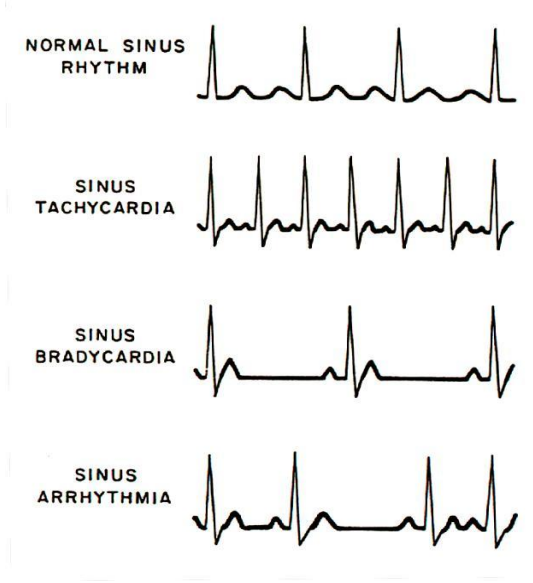
- The number of leads measured depends on the equipment.
- Three bipolar leads as a minimum, and three additional unipolar leads are usual.
- This type of procedure does require a quiet, calm environment (and animal) in order to optimize results. Distraction during the test may produce spurious results, and so care should be taken to let the animal settle in before measurement begins.
- An experienced technician or veterinarian should run the test and ideally, serial tests should be carried out and interpreted by the same individuals to help maintain consistency.
- Turn off fluorescent bulbs or electrical equipment (especially with older equipment) in the room and do not cross limbs or have contact with metal surfaces
- Before recording begins, clips must be effectively placed. RA and LA clips are best attached to the proximal olecranon area or even half way down the radius. The RL and LL clips are placed over the patella ligament. Before the clip is applied, remember to apply conductive gel or 70% isopropyl alcohol. The advantage of the latter is that it does not get gummed up in long hair. For longer term monitoring (e.g. intra-operative) gel is better since alcohol will evaporate too quickly. V clips are applied for precordial unipolar chest leads.
    1. Muscle tremors may result in artifacts. Movements are also a problem for recording leading to vibrations along the baseline. Purring can also produce this problem. A hand gently on the chest wall may help to reduce shivering.
    2. Wandering baseline is often due to respiratory cycle movements because contact at the skin-clip interface can be poor. Panting or coughing may also do the same thing. Gently holding the muzzle closed for 4 seconds

Equipment or supplies

Equipment is relatively inexpensive and ranges from trans-telephonic sets to integrated computer oscillometric recorders that can print and upload to the computerized patient record directly.

- Blanket or soft pad for table
- ECG recording machine The ECG apparatus should meet the requirements of the Committee on Electrocardiography of the American Heart Association. The amplifier is tied to a strip recorder, either on a computer screen, oscilloscope, or by stylus on wax paper. At minimum, single channel capture and an oscilloscope should be available. Three-channel equipment allows for more detailed capture and analysis by letting the tester record three leads at a time.
- Contact gel or 70% isopropyl alcohol
- Clippers if the hair is too thick to provide close clip contact.
- Printer or computer or trans-telephony device depending on where the results are to be sent / recorded.
- Separate out the cables so they do not overlap. Usually, this is a set of 5 wires. Alligator clips are usually used in animals. Plate clips are better for electric sensitivity but are more easily displaced in a struggling animal. Alligator clips should be filed and bent to be less pinching and be made of copper. In very small animals placing a plate inside the clip may help maintain comfort without loss of efficiency.
- Once all are attached, turn on the machine unless it is an older one that requires warm up; in that case, warm up before doing patient positioning
- For those with a stylus, a hand to steady it in the center may be needed.
- Run the marker for sensitivity, and go to 50 speed before you start to record.
- Change leads to obtain 4 second segments approximately, with the goal to record a minimum of 4 good complexes for rhythm disturbances. Repeat as needed to cover available leads for the system.
- Finally, record a long strip of Lead II for full rhythm assessment.
- A break will be needed if precordial leads are to be done as the electrodes will need to be repositioned. Turn off the machine, turn back on and run the standardization again before starting the recording.
- Turn off the record switch, turn off the machine and clean gel from the haircoat after gently removing the clips.
- For trans-telephonic ECG, the portable preamplifier converts electrical signal into tones that can be sent over a phone line. Position the animal then two electrodes are first attached to the forelimbs near the elbow and moistened for good contact, then make the call to the service

Figure 1. Common ECG Examples of Arrhythmias



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