ECG Quiz

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A three-years old intact male cat weighing 4.5 kg was presented at the Small Animal Teaching Hospital while he was in lateral recumbency. He went out from house for a few days and went back home with anorexia, lethargy and prominent weakness. The owner did not see his urination while he stayed at home. From physical examination, he was dehydrated by 10%. The abdominal palpation revealed he had urinary bladder distention. The blood was collected and showed the packed cell volume of 23.4 %. The cat had severe azotemia with blood urea nitrogen and plasma creatinine concentrations of 200 mg/dl and 11.8 mg/dl, respectively. The leukocytosis was found with white blood cell count of 57,700 cells/μL. Plasma protein and albumin were within normal limits. Plasma glucose was 140 mg/dl. Plasma electrolytes showed Na, 132 mM; K, 9.60 mM and Cl, 114 mM. Plasma HCO_3^- was 17.6 mM while PCO_2 was 28.8 mmHg. Blood pH was 7.328. The electrocardiography was performed as shown in Figure 1A. The abdominal radiography showed UB distention and radiopaque sediment at ventral portion of UB. The cat was diagnosed for lower feline urinary tract obstruction. The urinary plaque was seen while urinary catheter was introduced and fixed while he was administered fluid continuously. The result from urinalysis showed hematuria. The calcium gluconate 150 mg was slowly infused and the ECG was recorded 20 minute later as shown in Figure 1B. The second dose of 100 mg of calcium gluconate was administered and the ECG was re-recorded (Figure 1C). The antibiotics and analgesic drug were given along with fluid therapy. Post-obstructive diuresis was found the next day whereas animal was conscious with more alert. The cat was recovered and discharged from the hospital for the next few days.

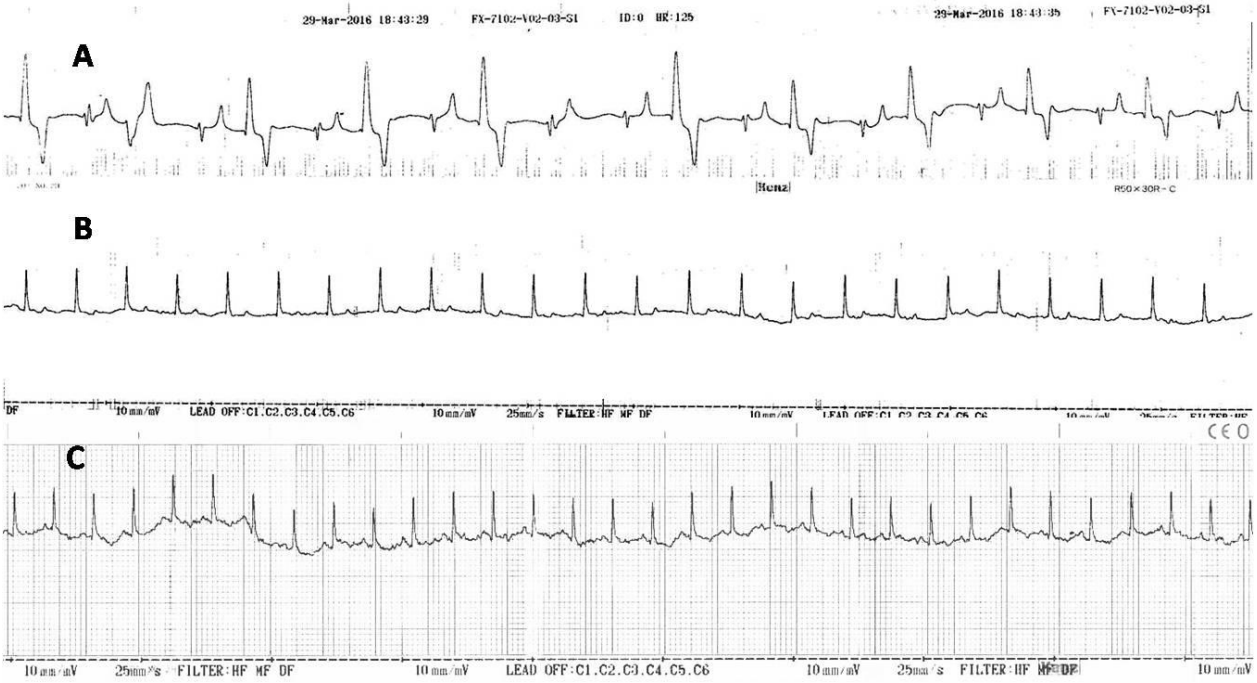

Figure 1 One ECG recording during first admitted to the hospital (A) , twenty minutes after the first dose of calcium gluconate infusion (B) and after the second dose of calcium gluconate infusion (C)

Please answer before turning to the next page.

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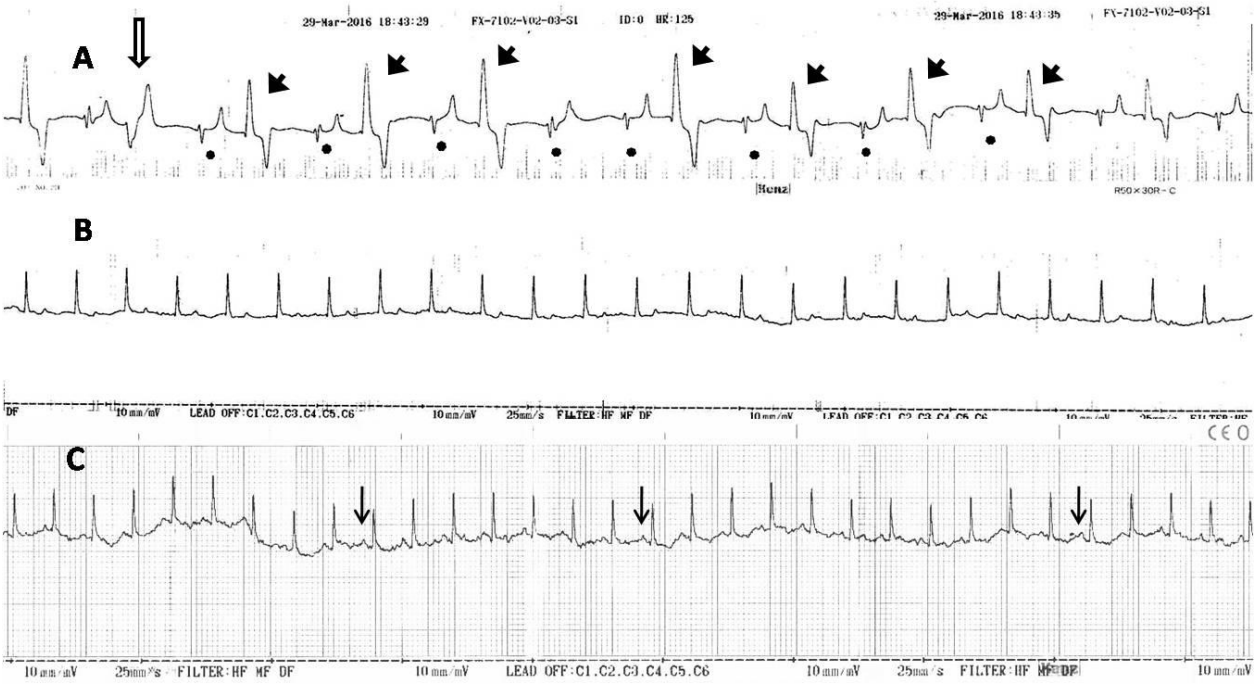
Interpretation

Figure 1A **Sinus rhythm with peaked T waves and a presence of left ventricular bigeminy**
Figure 1B and 1C **Normal sinus rhythm**



Since this cat had urinary obstruction, the plasma potassium was elevated up to 9.6 mM. The most common findings of ECG in hyperkalemia included abnormal repolarization, paralysis of atria, conduction abnormalities with bradycardia and inventually cardiac arrest when potassium is climbed up. The high extracellular potassium concentration reduces myocardial excitability with suppression of both pacemaking and conducting tissues. When potassium closed to 8 mM, the peaked T wave, loss of P-wave, prolonged PR interval, bradycardia and a presence of sine waves were found. The electrocardiographic recording in Figure 1A showed the QRS-T complexes originated from supraventricular in origin (dots). The heart rate in which impulses passing the Bundle of His and spread throughtout the ventricle was approximately 60 beats per minute. The P-wave of atrial depolarization was invisible which is common in cat due to small voltage. The negative deflection of QRS complexes was seen with talled and symmetrical T-wave. Moreover, the QT prolongation was found (0.36 second). Please notice the abnormal ventricular ectopic beats which arised after the normal complexes (short arrows). The abnormal bizzared shape composed of pronounced positive deflection followed by negative T-waves. These complexes were ventricular ectopic beats which arised from the left side and were coupled with normal complexes resulting in constant duration of ectopic beats and the preceding T-waves as called "left ventricular bigeminy". The mechanism may be due to the reentry process. Ectopic beats and ventricular rhythm could be found when serum potassium is higher than 8.0 mM. The ectopic beat may emerge from different location as seen by complex with variable shape (open arrow). If plasma potassium was severely high, the heart block, ventricular fibrillation or asystole will be encountered resulting in fatal arrhythmia. Severe hyperkalemia needs emergency treatment to protect the cardiac electrical instability by administration of calcium gluconate. The other intervention includes enhancing the potassium entry into the cell by injecting insulin with glucose. The diuretics may be given later to increased urinary potassium excretion. In this cats, calcium gluconate was administered and the ECG recording 20 minutes later showed ECG with regular rhythm (Figure 1B). The impulses may be originated from sinus although the P-wave was difficult to be seen. The heart rate was elevated by double with no ventricular ectopic beats. When calcium gluconate was re-administered, the ECG showed higher heart rate in which impulses were certainly originated from sinus as shown by the presence of P-waves (straight perpendicular arrows)(Figure 1C). After treatment for a few days, the cat was fully recovered since urinary obstruction was corrected immediately after admission along with fluid therapy. Plasma potassium concentration was declined to a normal level one day after hospitalization.