Case Reports

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Lewis Lead: Reveal The Hidden P Wave

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Abstract

Background: Lewis lead configuration can help to detect atrial activity and its relationship to ventricular activity, so diagnosis can be achieved more accurately. With Lewis lead ECG, it will make easier to make a diagnosis, especially in identifying electrical activity in atrium.

Case illustration: Case 1. A 61-year-old male with decreased consciousness. From a standard 12-lead ECG, P waves are difficult to identify. From Lewis ECG in lead I, it appears P wave with more than 3 forms, that showed as multifocal atrial tachycardia (MAT). Case 2. A 58-year-old male patient complained of typical ischemic chest pain. A standard 12 lead ECG examination revealed a wide QRS tachycardia with rate 210 beats/minute. From Lewis ECG in lead I, we can clearly see P waves with AV dissociation, so VT management can be done immediately. Case 3. A 65-year-old male patient diagnosed with grade 5 CKD on dialysis. From a standard 12 lead ECG examination, a wide QRS wave with a P wave is obtained which is sometimes seen behind QRS wave, making diagnosis difficult to establish. From Lewis ECG in lead I, P wave always appears at the end of QRS wave, so it can be seen that rhythm from ECG is derived from accelerated idioventricular rhythm with ventriculoatrial conduction.

Conclusion: Lewis lead ECG clinical importance in all three cases. With Lewis lead ECG method, cardiac electrical activity will be more visible, so it will be helpful in interpretation of ECG in cases that P wave are not clear on standard 12 lead ECG examination.

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Keywords: P wave, Lewis lead, Electrocardiography.

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Introduction

Electrocardiography is standard cardiovascular examination required in many situations. However, using a standard 12 lead ECG only is sometimes can be difficult to determine cardiac electrical activity in some cases.[1] Lewis lead configuration can help to detect atrial activity and its relationship to ventricular activity, so diagnosis can be achieved more accurately. This technique was described by Sir Thomas Lewis (1881 to 1945) in his book Clinical Electrocardiography.[2] This case report attempts to describe several cases with ECG waves which are difficult to identify with standard leads. With Lewis lead ECG, it will make easier to make a diagnosis, especially in identifying electrical activity in atrium.

Patent foramen ovale is indeed a major cause of CS, and its role as a culprit, risk factor, or a coincidental finding is questionable. The mechanism of the stroke that occurs is still uncertain.[4] This paper presents a series of CS cases highly suspected due to patent foramen ovale origin with each of its special presentations.

Case Illustrations

Case 1

A 61-year-old male with decreased consciousness, uncontrolled type II diabetes mellitus, azotemia, and severe hyperkalemia. From a standard 12-lead ECG, P waves are difficult to identify, and narrow QRS waves are irregular. So that at first glance it looks like atrial fibrillation (**Figure 1.A**). However, because some QRS waves appear to have an unclear P wave, an ECG is recorded using Lewis leads. From Lewis ECG in lead I, it appears that QRS wave is always preceded by a P wave, with different morphologies (more than 3 forms). This showed that patient's ECG was multifocal atrial tachycardia (MAT) with a heart rate of 120 beats / minute (**Figure 1.B**).

Case 2

A 58-year-old male patient complained of typical ischemic chest pain and palpitations that had been felt since 2 days before admission to hospital. Patient was an active smoker since adolescence. A standard 12 lead ECG examination revealed a rhythmic tachycardia with a wide QRS wave at a rate of 210 beats / minute. To determine whether the wave is a VT or SVT with aberration, Brugada or Vereckei criteria are used. Where two criteria include AV dissociation as one of the important criteria. On a standard 12 lead ECG it is difficult to determine AV dissociation, because the P waves are difficult to identify (**Figure 2.A**). So, Lewis's lead ECG was recorded with adjusted calibration to 1 mV/20 mm. From Lewis ECG in lead I, we can see that P waves that appear are not always followed by QRS (**Figure 2.B**). Thus, it can be seen AV dissociation is a VT, so VT management can be done immediately.

Case 3

A 65-year-old male patient diagnosed with grade 5 CKD on dialysis, acute gastroenteritis with dehydration, and hyperkalemia of 7.8 mmol / L. From a standard 12 lead ECG examination, a wide QRS wave with a P wave is obtained which is sometimes seen behind QRS wave, making diagnosis difficult to establish (**Figure 3.A**). From Lewis ECG in lead I, P wave always appears at the end of the QRS wave, so it can be seen rhythm from ECG is derived from accelerated idioventricular rhythm with ventriculoatrial conduction (**Figure 3.B**).

Discussion

Three cases of patients with different diagnoses have been reported. When a standard 12-lead ECG is performed, results are difficult to identify cardiac electrical activity. In an effort to establish diagnosis of these patients, ECG recording was performed using Lewis lead method.

Lewis-recording ECG is performed by moving the electrode in the right hand to second intercostal right parasternal line, left hand to the fourth intercostal right parasternal line, and other electrodes are left as per standard ECG recording. By changing the configuration of these leads, the cardiac vector will shift so that lead I will travel directly over the atria. Therefore, the P wave will be more visible in lead I. Calibration can be adjusted to 1 mV/20 mm to improve visualization of P wave.[2] In all three cases, P wave was more visible on ECG examination using Lewis lead method than using standard 12 lead ECG method, with only case 2 illustration uses calibration adjustment.

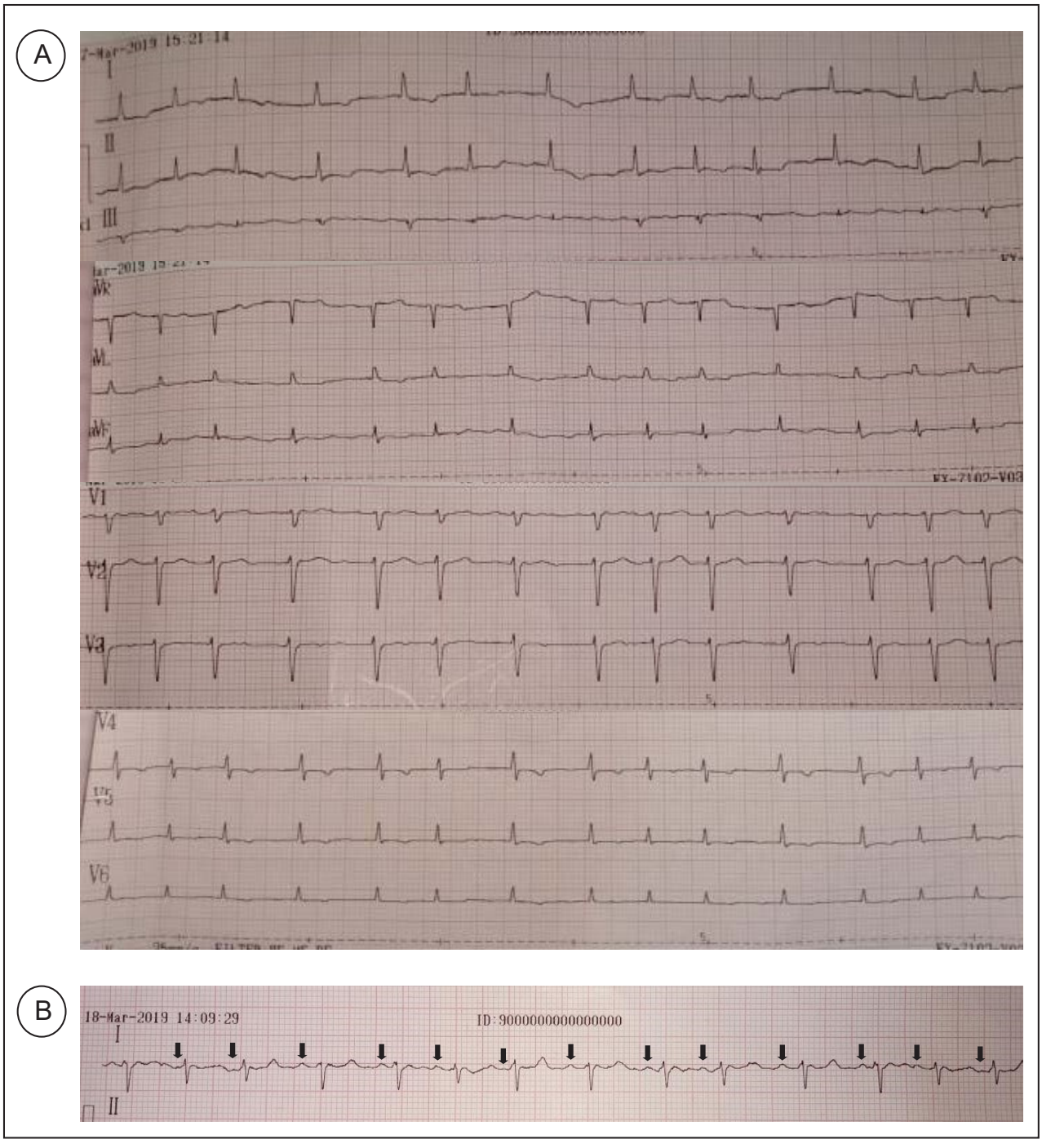

Figure 1. (A) Standard 12-lead ECG; (B) Lewis lead ECG showed that QRS wave is always preceded by a P wave (arrow).

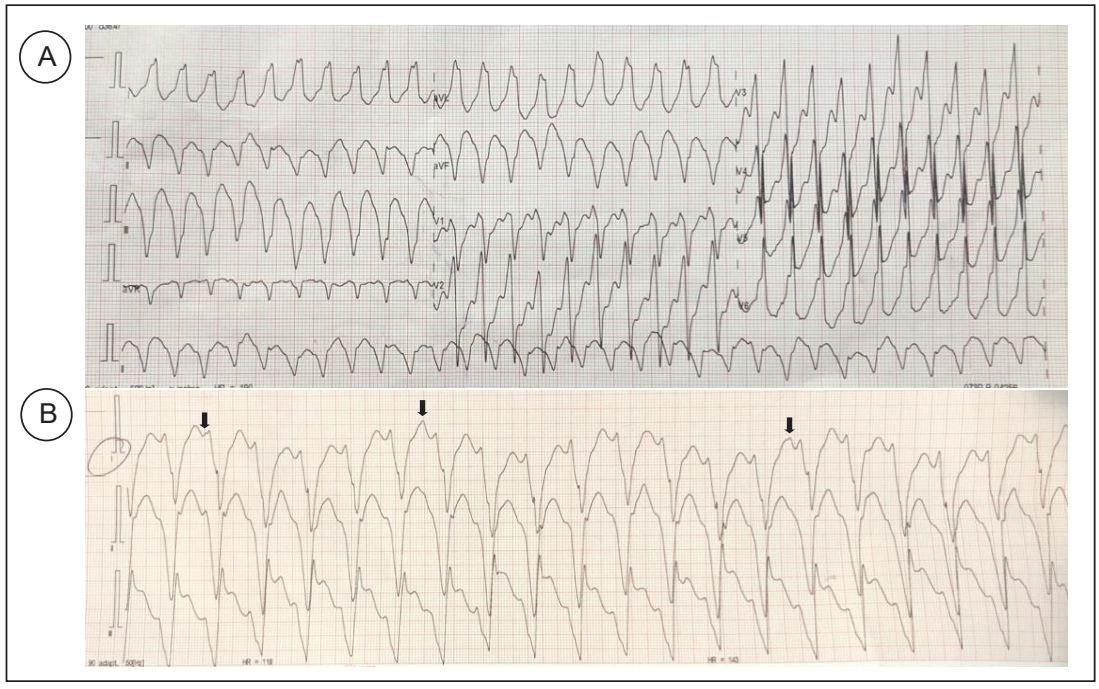

Figure 2. (A) Standard 12-lead ECG; (B) Lewis lead ECG showed P waves (arrow) that appear are not always followed by QRS.

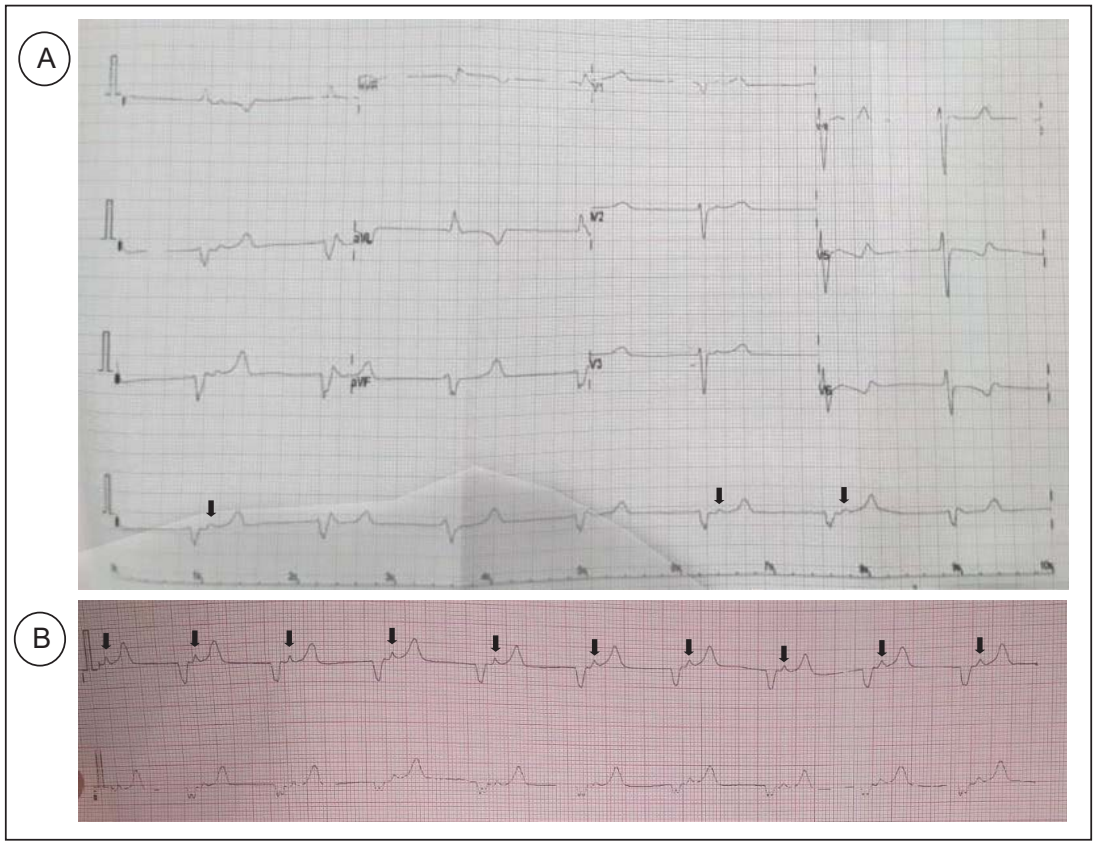

Figure 3. (A) On, standard 12-lead ECG a wide QRS wave with a P wave (arrow) is obtained which is sometimes seen behind QRS wave; (B) Lewis lead ECG showed P wave always appears at the end of QRS wave (arrow).

Lewis lead ECG has known provide more information about AV dissociation than standard 12 lead ECG. AV dissociation is very useful for diagnosing rhythm tachycardia with wide QRS, because it is very specific for VT. Lewis lead ECG has also been shown to detect P waves during tachycardia. In a case report, the use of Lewis ECG leads was shown to detect independent P waves (approximately 60 beats/min) in wide QRS complex at a rate of 120 beats/min.[4] In another case, it was reported Lewis ECG leads can also show AV dissociation in wide QRS complex tachycardia with a faster heart rate of 150 beats/min.[5]

A prospective, operator-blinded study showed potential benefit of a Lewis lead ECG in comparison with standard 12-lead ECG. On that study, patients underwent electrophysiological study, stimulated with a fixed cycle length of 400 ms in ventricle, During stimulation, a standard-lead ECG and a modified Lewis lead ECG were recorded. Simultaneously, VA conduction was documented by intracardiac electrograms. Surface ECGs were presented to 6 blinded examiners for VA conduction assessment. As result, type of ventriculo-atrial conduction was correctly diagnosed in significantly more ECGs in Lewis lead ECG group than in standard-lead ECG group (p= 0.045).[1]

Another study using a quadripolar diagnostic catheter directed to right ventricular apex, a fixed stimulus was given and Wenkebach point was found, and a VT was simulated by a RV apical stimulus at 300 ms. When standard and Lewis lead ECG records were taken during this procedure, there was a statistically significant difference between groups on terms of the 'visible P waves' (p = 0.022). The sensitivity of standard and Lewis lead ECG in determination of the visible P waves was 33.3% and 66.7%, respectively.[3]

Several studies investigated changes in the P waves that occur on the ECG using the Lewis lead method. One study measured amplitudes of P wave on Lewis lead through a saline-filled central venous catheter. Result from this study is that visibility change of P waves might caused by different P wave-to-QRS amplitude relationship.[6]

Another study says that changing the position of the right and left arm electrodes on Lewis lead ECG will change the average potential of the Wilson's central terminal, which is used as negative pole for the 3 augmented limb Goldberger leads and the 6 precordial leads. This explains why Lewis lead ECG appears to be different in all 12 leads.[1]

Compared with standard-lead ECG, Lewis lead ECG is associated with significantly improved detection of AV and VA conduction type and thus may help improve ECG diagnosis.[1] Moreover, in diagnosing an arrhythmia in intensive care or emergency room, Lewis lead can be performed using ECG monitor lead only as a simple method to implement, without having to use a 12-lead ECG machine

Limitations

Due to limited resources, electrophysiological examinations to properly establish cardiac electrical activity have cannot be performed in these three patients. However, from several studies have been presented, Lewis lead ECG can reveal P waves significantly, so it can help improve patient's diagnosis.

Conclusions

Lewis lead ECG clinical importance in all three cases. With Lewis lead ECG method, cardiac electrical activity will be more visible, so it will be helpful in interpretation of ECG in cases that P wave are not clear on standard 12 lead ECG examination.

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Conflict of Interest Statement

Authors declare no conflict of interests for this article, also have read and approved the final manuscript.

List of Abbreviations

AV : Atrio-Ventricular
CKD : Chronic Kidney Disease
ECG : Electrocardiography
SVT : Supraventricular Tachycardia
VA : Ventriculo-Atrial
VT : Ventricular Tachycardia

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