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Short Communication

Changes in Electrocardiogram after Intramuscular Injection of Graphene using Salt-Intercalation Exfoliation

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ABSTRACT

Remarkable electrocardiogram changes were observed to evaluate the liquid chemical exfoliation effects of the three-dimensional structure of graphene using sodium chloride with potassium chloride solution. This study found that a solution of sodium chloride and potassium chloride could be a strong candidate as a thrombolytic agent acting against foreign graphene oxides in the blood of patients with or without the intramuscular injection of graphene.

Keywords: Graphene; EKG; Exfoliation; Sodium chloride; Potassium chloride

ABOUT THE STUDY

Graphene is a 2D transparent nanomaterial that is both durable and flexible. It is classified as an allotropic form of carbon with the size of a single layer of graphite. In 2004, graphene was first introduced to the world when Geim and Novoselov managed to segregate a single atomic layer of carbon. Since then, this promising material has drawn the attention of many researchers in the domains of materials science and mechanical engineering to manufacture and exploit it (Figures 1-5). The prospective use of graphene-based materials in a biological context requires a detailed comprehension of the toxicity of these materials. Moreover, due to the expanding applications of nanotechnology, human and environmental exposures to graphene-based nanomaterials are likely to increase in the future. Because of the potential risk factors associated with the manufacture and use of graphene-related materials, the number of nano-toxicological studies of these compounds has been increasing rapidly in the past decade. These studies have researched the effects of the nano-structural/biological interactions on different organizational levels of the living system, from biomolecules to animals [1] (Figures 6-10). Graphene family materials have attracted both academic and industrial interest as they can produce a dramatic improvement in materials properties at very low filler content.

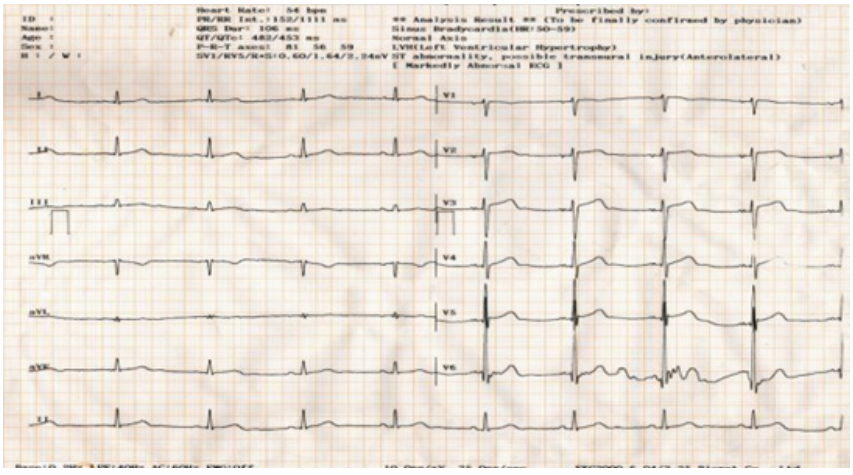

Figure 1A: Case 1 55 years old male patient who had anterolateral ST segment elevation with LVH and bradycardia.

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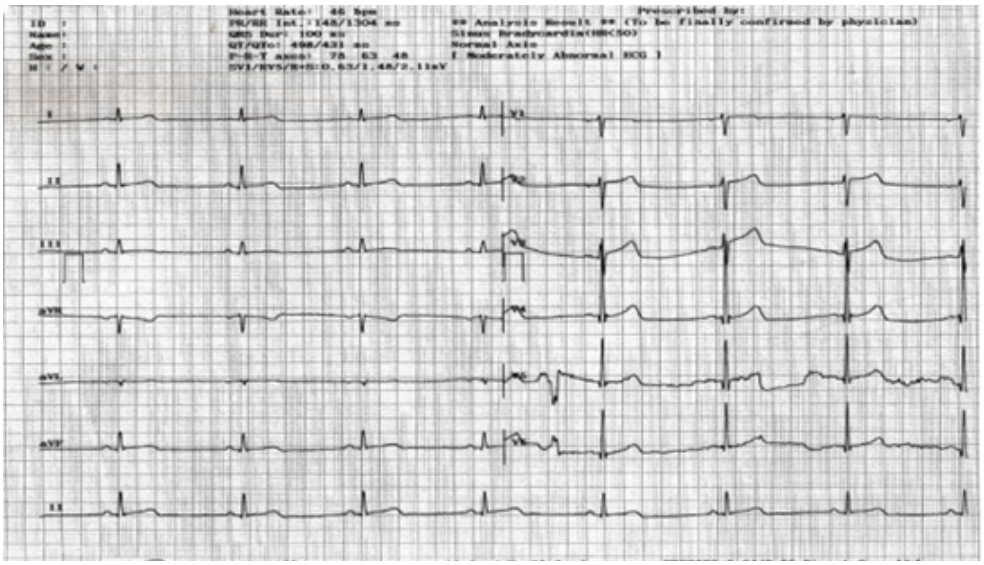

Figure 1B: Case 1Bradycardia Disappeared after exfoliation on EKG, Sinus bradycardia remains.

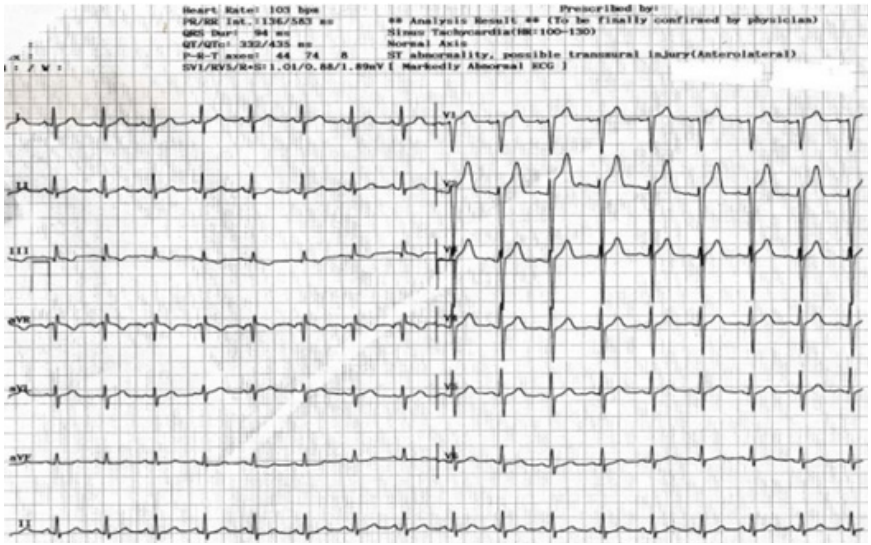

Figure 2A: Case 2-48 years old male patient who had anterolateral ST segment elevation with tachycardia.

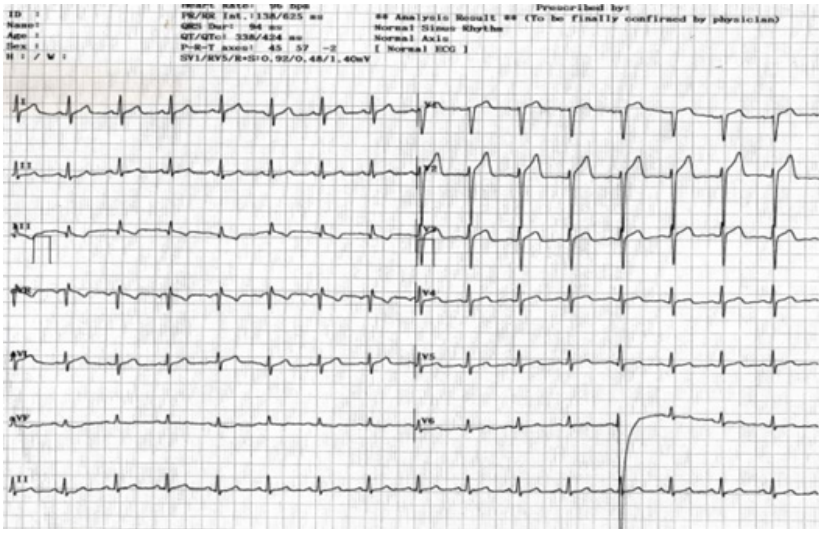

Figure 2B: Tachycardia disappeared completely after exfoliation in case 2.

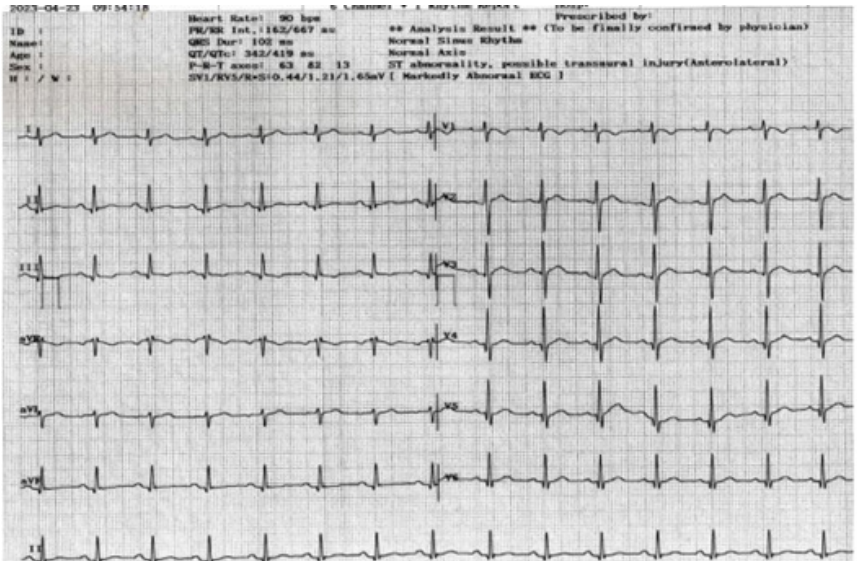

Figure 3A: 50 years old male patient who had anterolateral ST segment elevation in case 3.

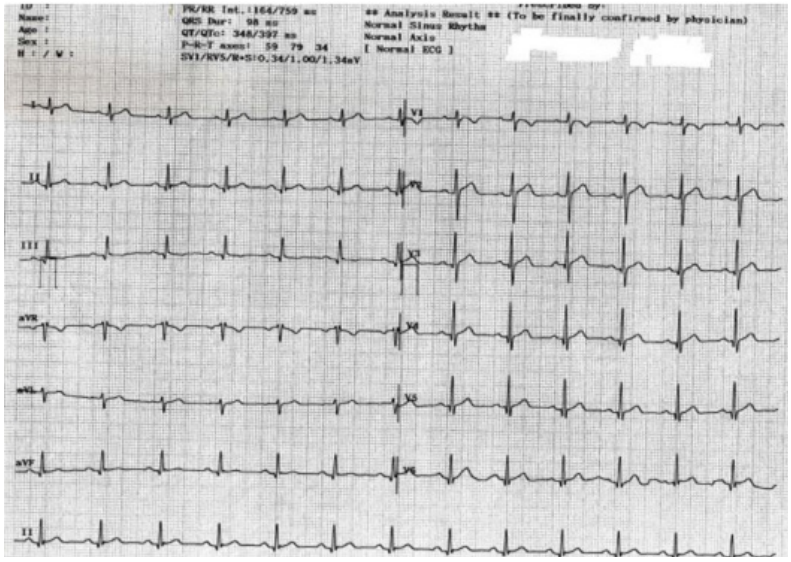

Figure 3B: Anterolateral ST segment elevation disappeared completely after exfoliation in case 3.

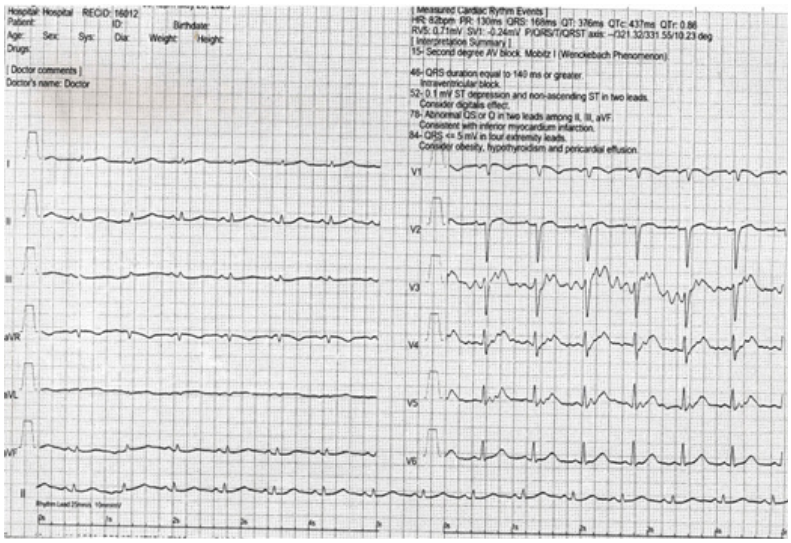

Figure 4A: 50 years old male patient who had abnormal Q wave in II, III, aVF leads with Wenchebach second degree AV block in case 4.

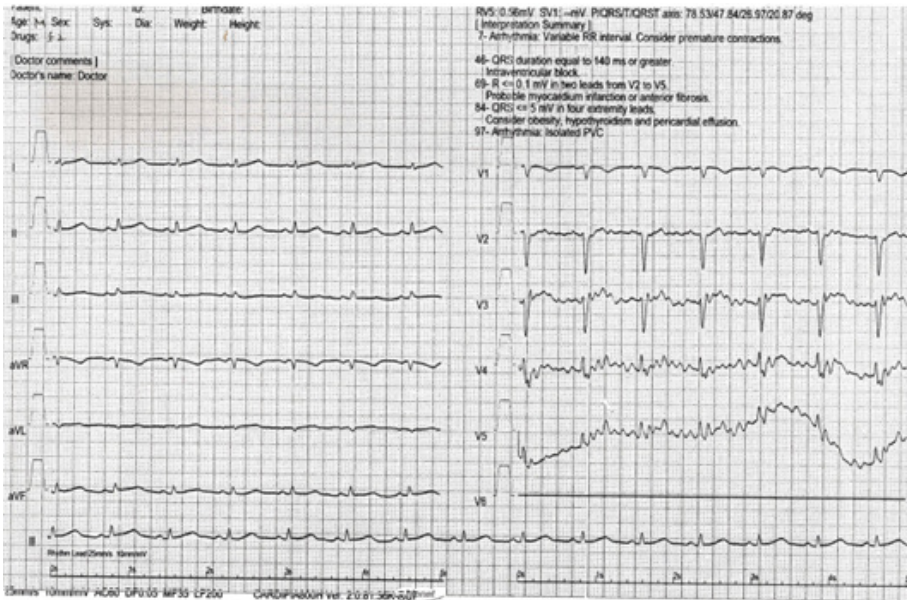

Figure 4B: Abnormal Q wave disappeared with isolate PVC after exfoliation in case 4.

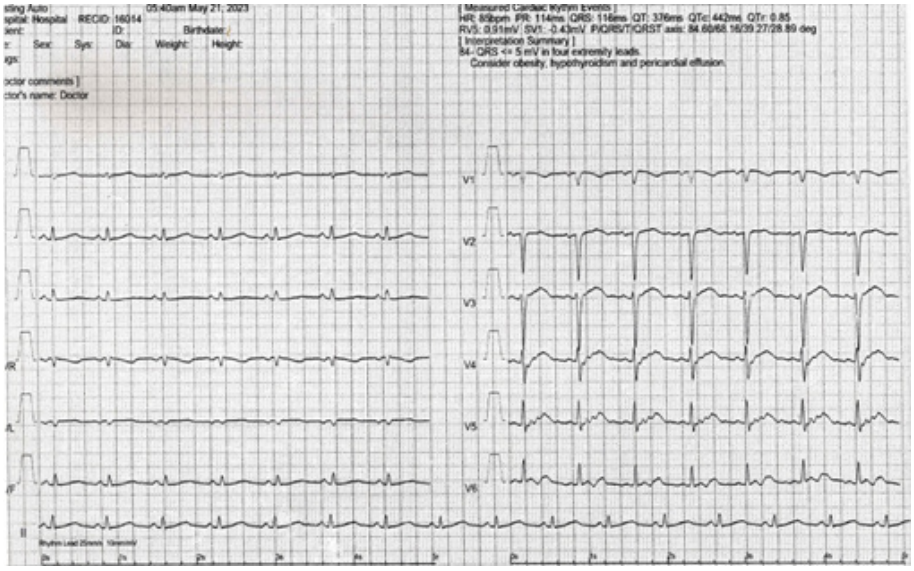

Figure 4C: The follow-up EKG after 6 hours, shows no abnormal Q wave, which means this change is not temporal in case 4.

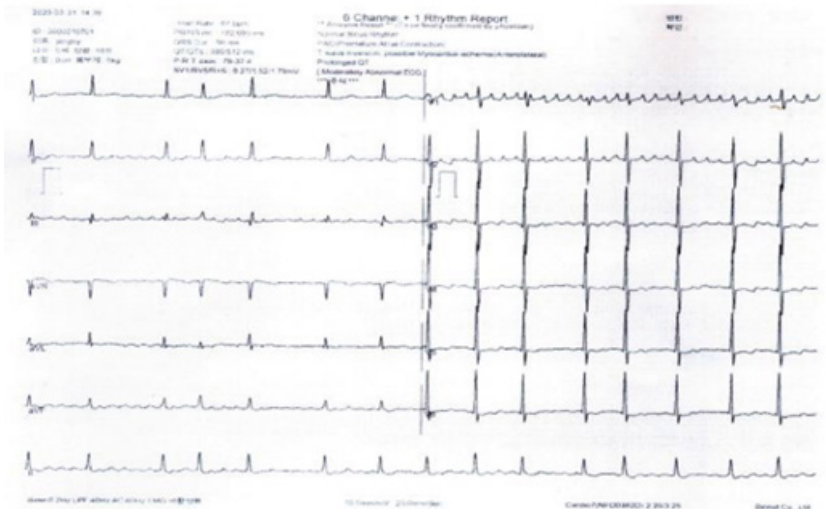

Figure 5A: 89 years old female patient who had PAC and T-wave inversion in anterolateral segment in case 5.

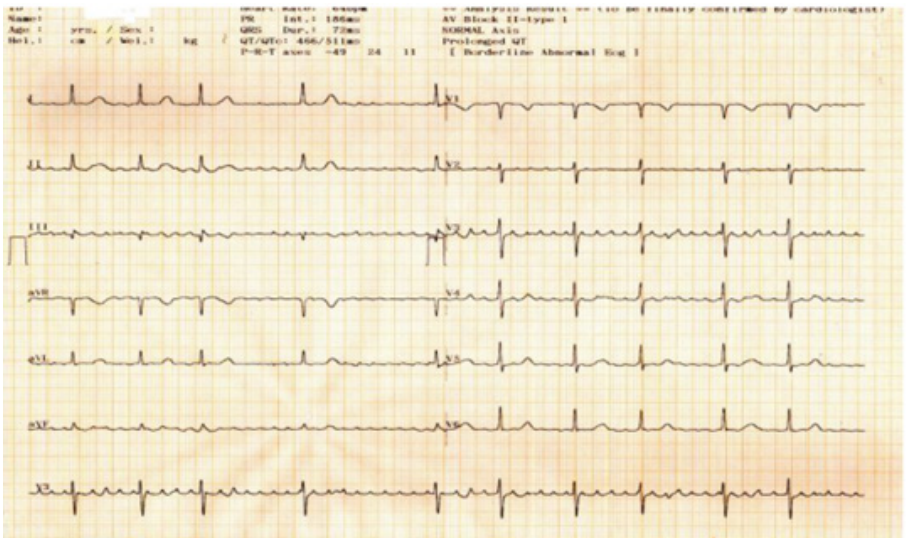

Figure 5B: Disappeared after 2 hour fluid exfoliation using NaCl with KCl on EKG recording. QT prolongation remains with first degree AV block in case 5.

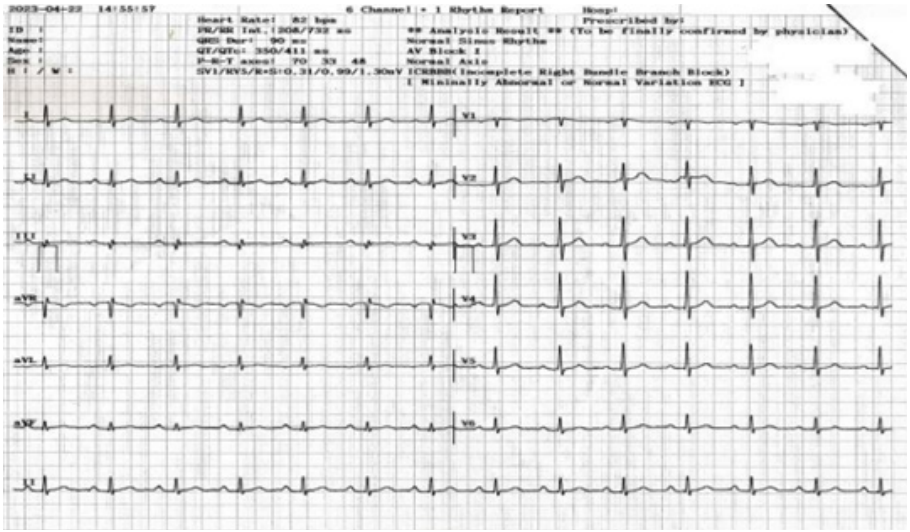

Figure 6A: 56 years old male patient who had incomplete right bundle branch block with first degree AV block in case 6.

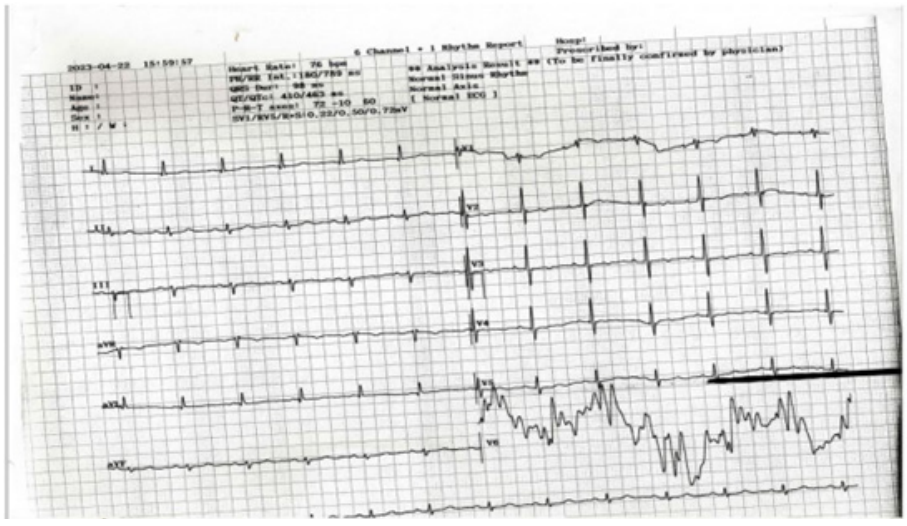

Figure 6B: Right bundle branch block with first degree AV block disappeared completely after exfoliation in case 6.

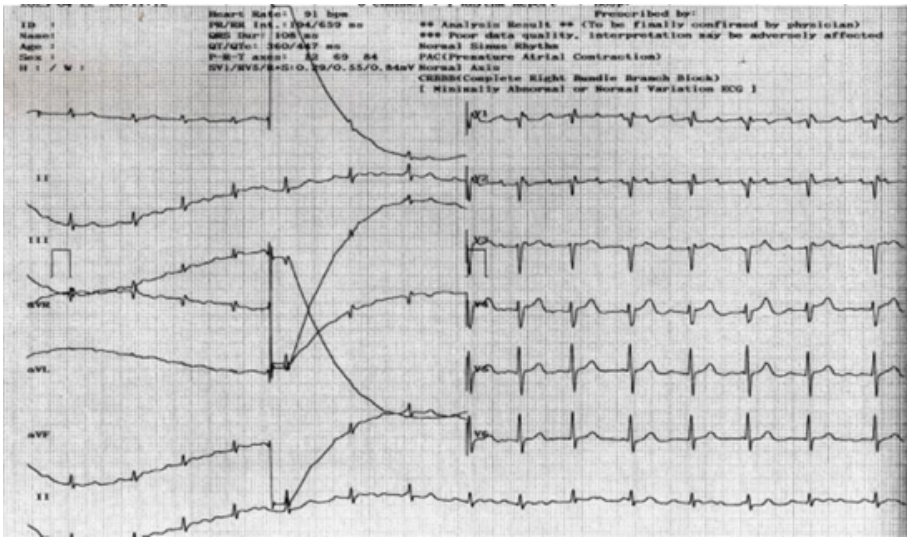

Figure 7A: 57 years old male patient who had complete right bundle branch block with PAC in case 7.

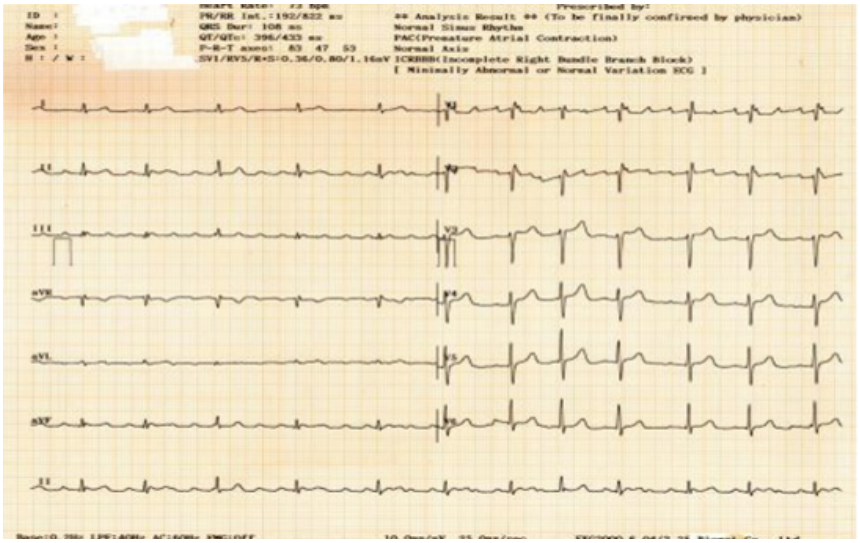

Figure 7B: 57 years old male patient incomplete right bundle branch block becomes incomplete after exfoliation in case 7.

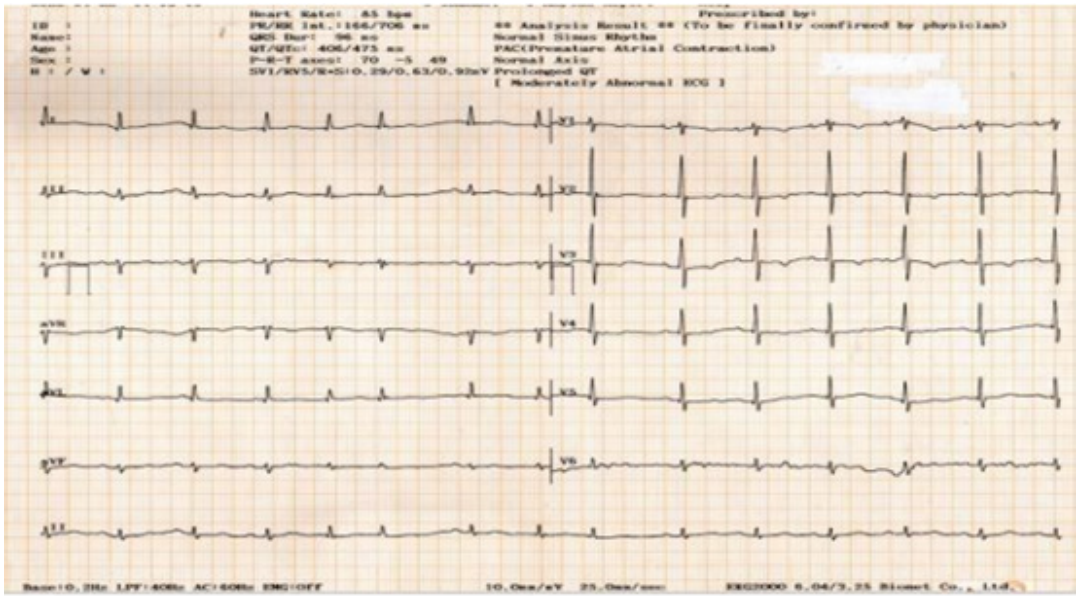

Figure 8A: 48 years old female patient who had PAC with QT prolongation in case 8.

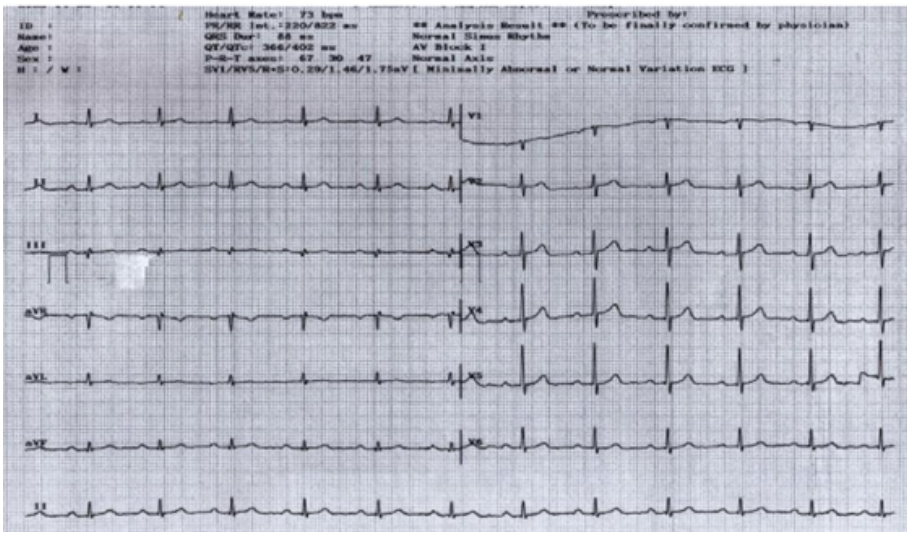

Figure 8B: PAC with QT prolongation disappeared completely after exfoliation in case 8.

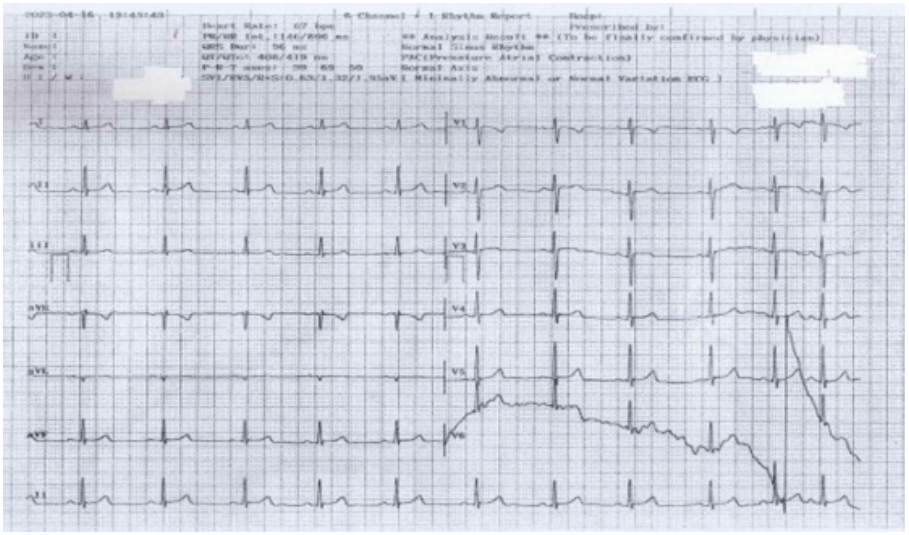

Figure 9A: 14 year's old girl with PAC on initial EKG in case 9.

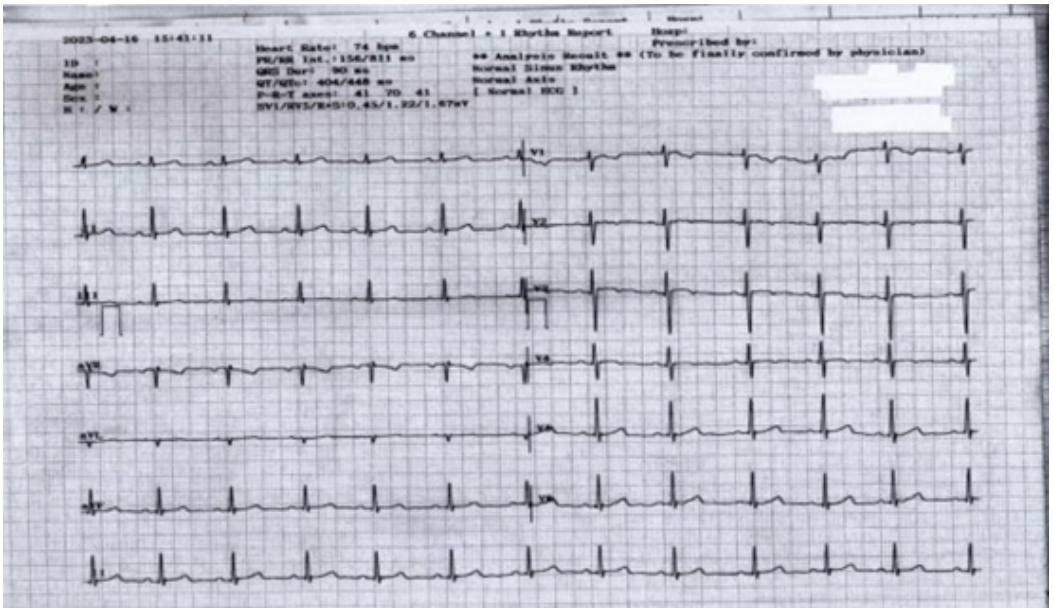

Figure 9B: Which had been erased after exfoliation removed her chest pain in case 9.

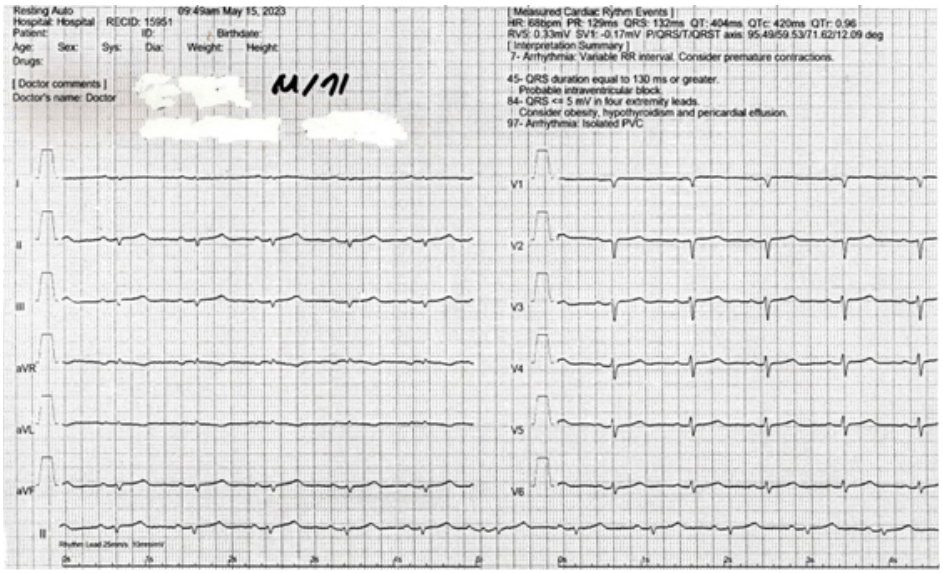

Figure 10A: 71 years old male patient who had isolated PVC in case 10.

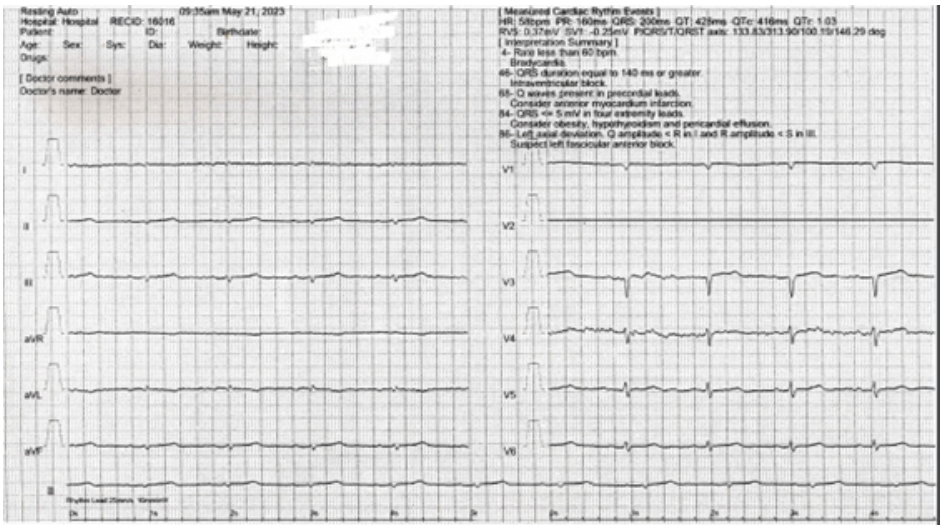

Figure 10B: Isolated PVC Disappeared completely after exfoliation in case 10.

Graphene family materials have drawn much scientific attention and technological interest since their discovery due to their unique electronic and mechanical properties, specific magnetism, excellent mobility of charge carriers, and high thermal conductivity. High surface area, excellent conductivity, outstanding mechanical strength, and extraordinary electro-catalytic activities of these materials have also been reported in the literature. Direct or indirect generation of Reactive Oxygen Species (ROS) leading to oxidative stress in target cells is currently the main mechanism proposed for the toxicity of engineered nanomaterials. Generation of ROS in target cells is a potential mechanism for graphene toxicity. It should be also noted that cellular homeostasis process produces a balance between the level of ROS generation and its elimination or reduction by antioxidant enzymes. The level of ROS is balanced by the action of superoxide dismutase, catalase, or glutathione peroxidase. When it cannot be reduced by cellular antioxidant activity, this may lead to alteration of macromolecules such as polyunsaturated fatty acids in membrane lipids, protein denaturation, and ultimately DNA destruction (Figures 11-14).

Both anions and cations are inserted in the space between conjugated graphite layers during the intercalation process [2,3]. The anion can enhance the salt-intercalation exfoliation by expanding the interlayer spacing. Compared with sodium chloride alone, a solution containing potassium chloride and sodium chloride can significantly enhance the exfoliation yields of graphene. Optimizing the cation and anion species can improve the yield of graphene because co-intercalation with both anions and cations occurs during the intercalation process in the inorganic salt solution [4]. This case series included all patients admitted at our outpatient department with various cardiovascular diseases, which had been identified on EKG recordings after intramuscular graphene injection. Between March 31 and May 22, 2023, seventeen patients' median age was 57 years old (range, 14-89 years), and most patients were male (n=12 (70%)). All patients received the intramuscular graphene injection. Chest pain, with left arm pain (in one patient) in three patients (16%) started at median 3 days (range, 2-5 days) after receiving the injection and stop immediately. Other symptoms included fever in four patients (25%), myalgia in five patients (30%), and headache in five patients (24%). No patients required intensive care unit admission (Figures 15-17).

Figure 11A: 53 years old male patient who had Mobitz type 2 second degree AV block in case 11.

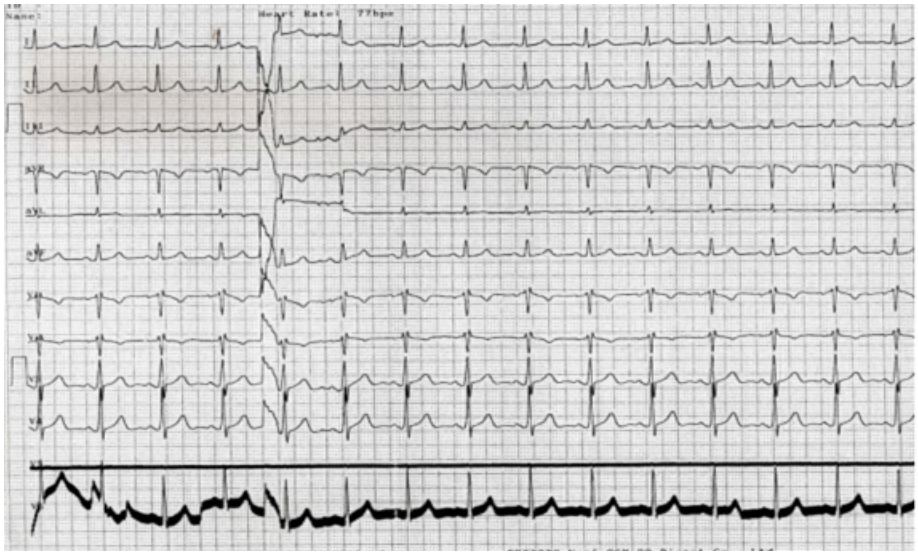

Figure 11B: 2 second degree AV block disappeared completely after exfoliation in case 11.

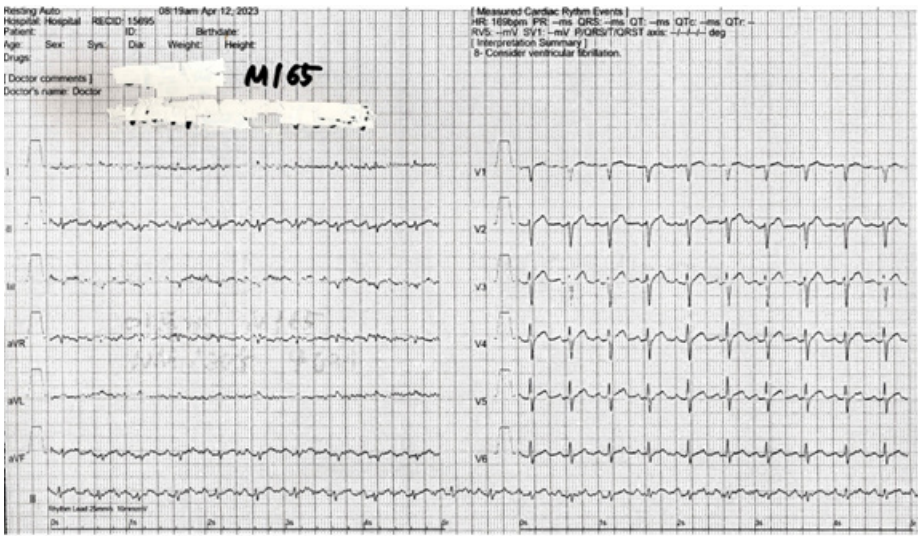

Figure 12A: 65 years old male patient who had ventricular fibrillation in case 12.

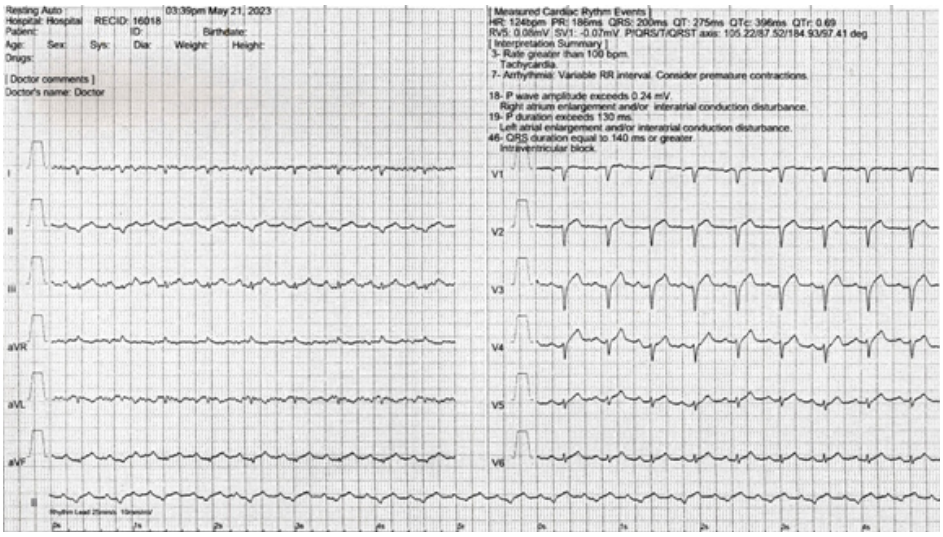

Figure 12B: Had changed to intraventricular block with both ventricular enlargements after exfoliation in case 12.

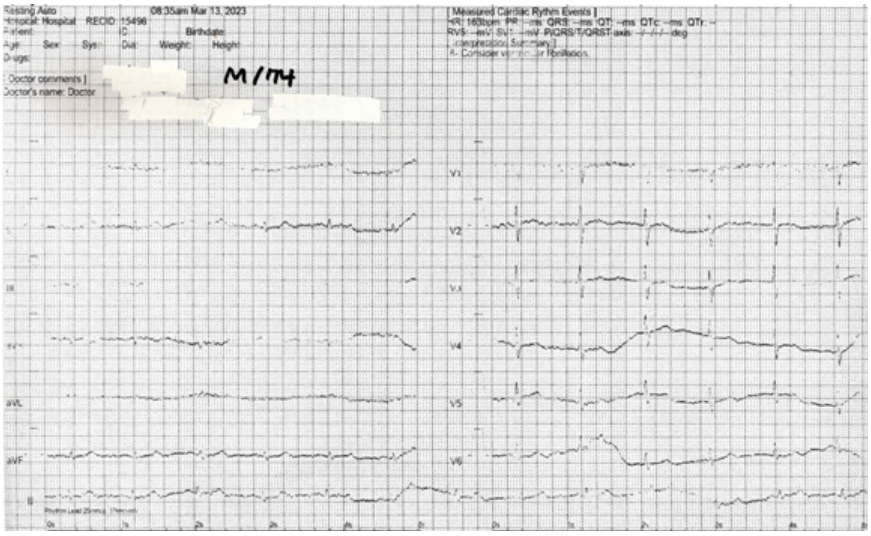

Figure 13A: 65 years old male patient who had ventricular fibrillation in case 13.

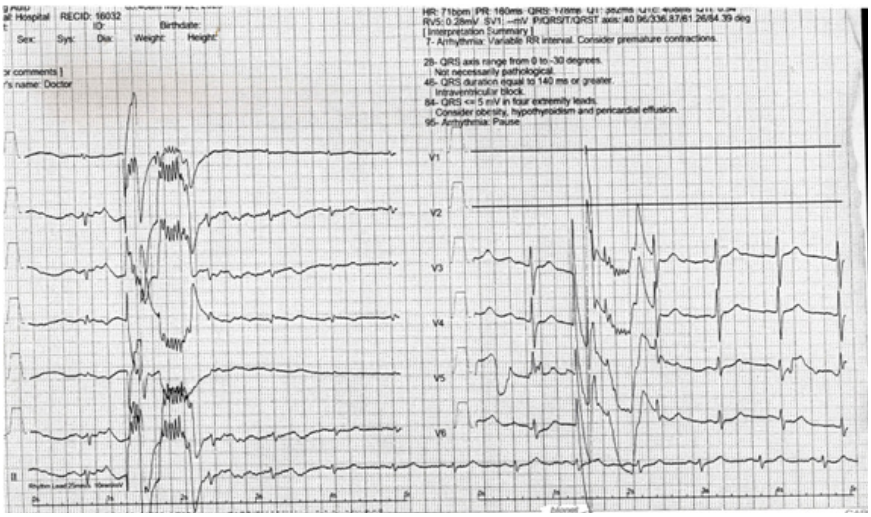

Figure 13B: Had changed to intraventricular block after exfoliation in case 13.

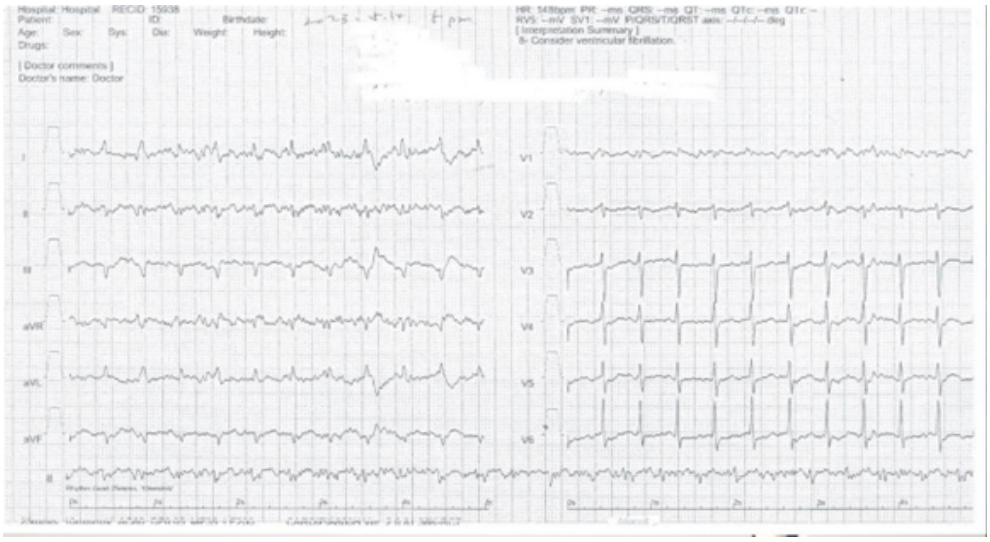

Figure 14A: 60 years old female patient who had ventricular fibrillation in case 14.

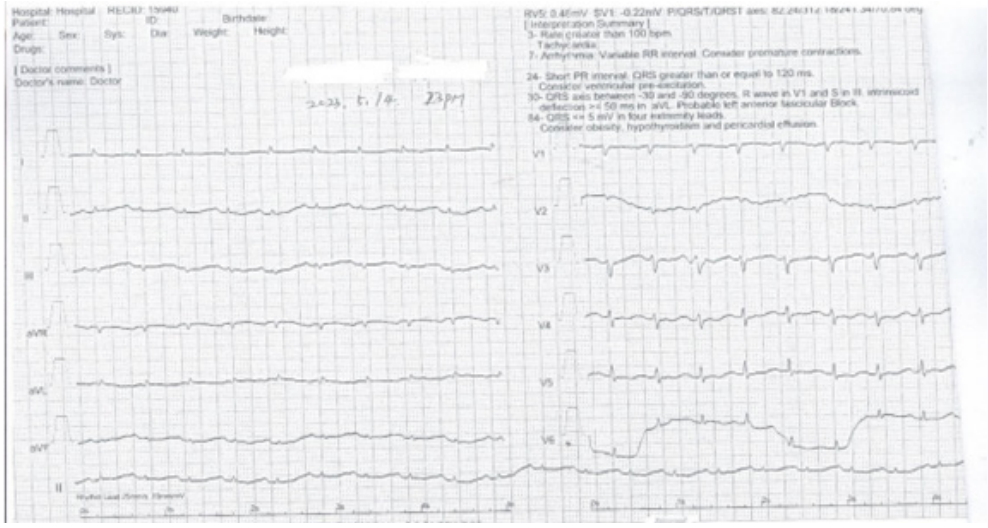

Figure 14B: Had changed to left anterior fascicular block with pre-excitation (WPW syndrome) after exfoliation in case 14.

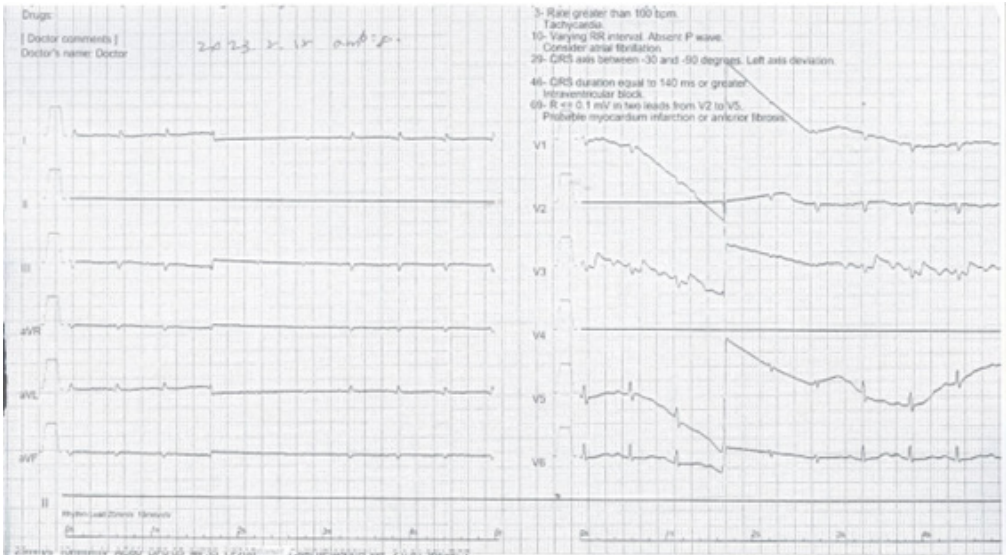

Figure 14C: The follow-up EKG after 6 hours, shows remained interventricular block, which means this change from ventricular fibrillation to interventricular block is not temporal in case 14.

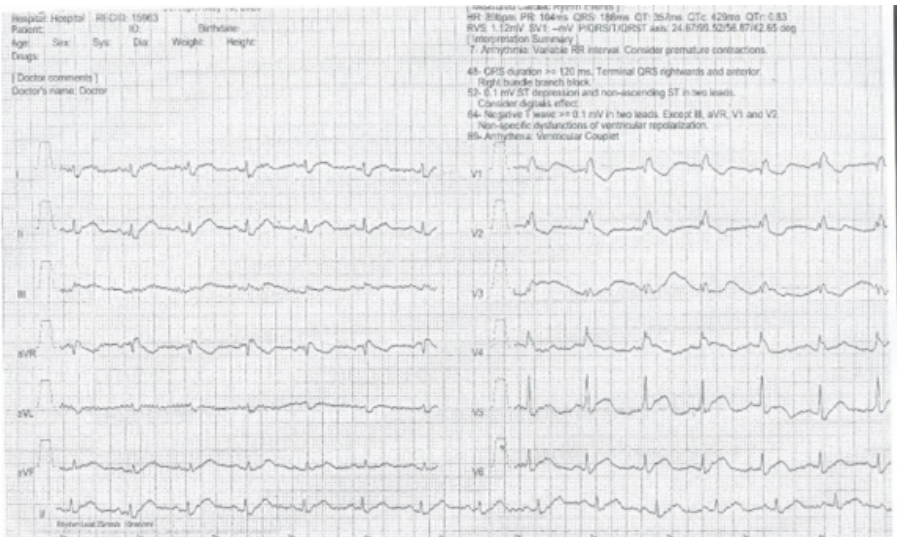

Figure 15A: 49 years old male patient who had ST segment depression with T wave inversion in case 15.

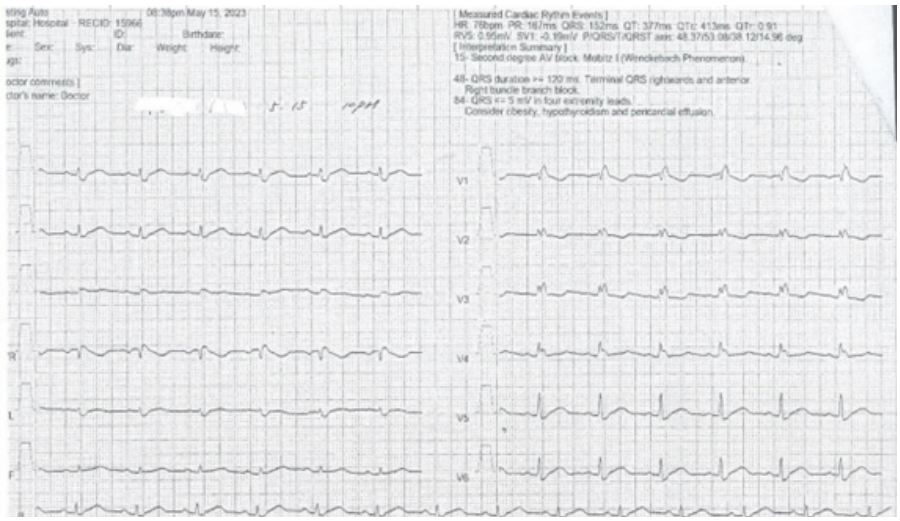

Figure 15B: Had changed to 2 second degree AV block after exfoliation in case 15.

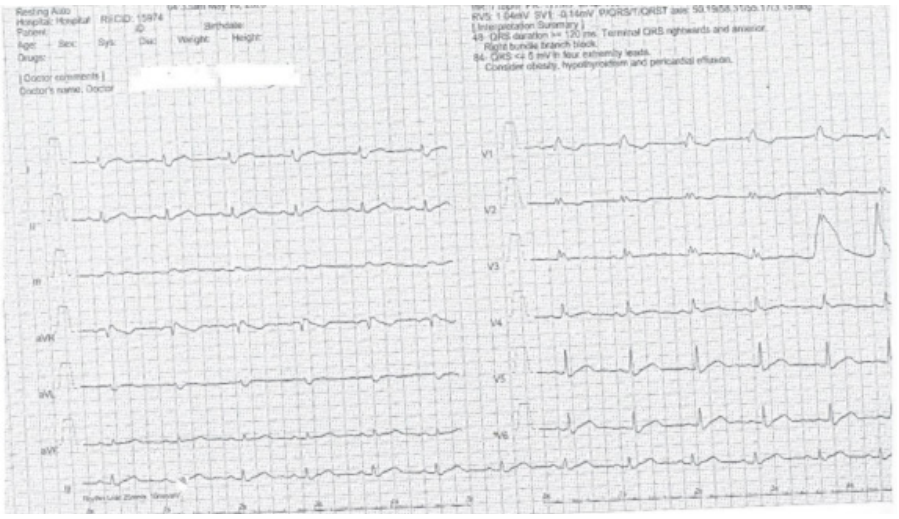

Figure 15C: The follow-up EKG after 6 hours, shows normalized EKG which means this change is not temporal in case 15.

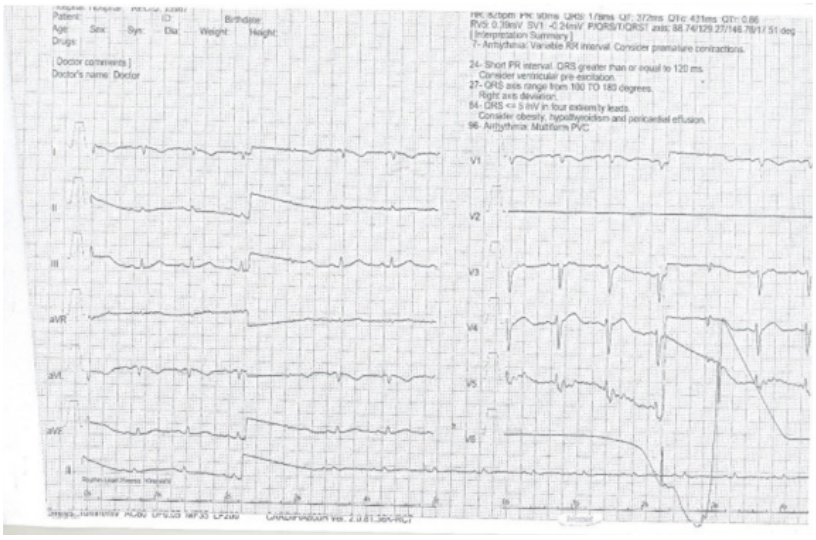

Figure 16A: 53 years old male patient who had PVC with pre-excitation (WPW syndrome) in case 16.

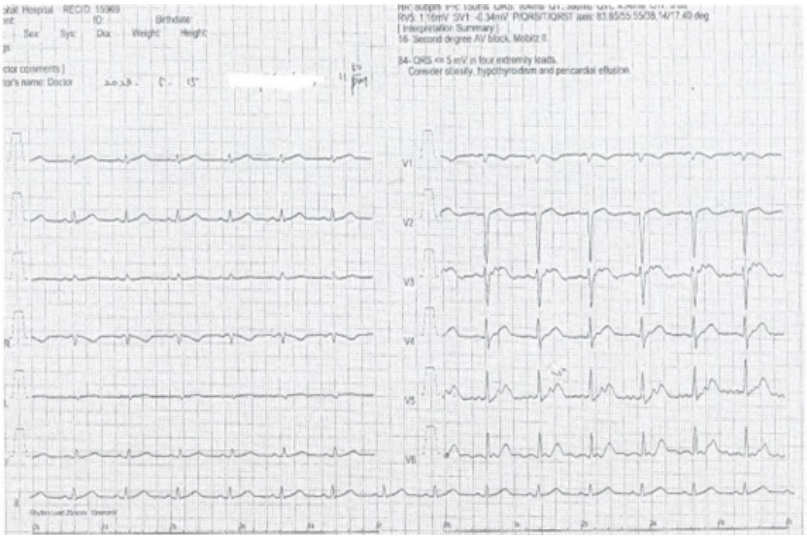

Figure 16B: Had changed to Mobitz type 2 second degree AV block after exfoliation in case 16.

Figure 16C: The follow-up EKG after 6 hours, shows reduced R wave voltage, which means this change is not Temporal in case 16.

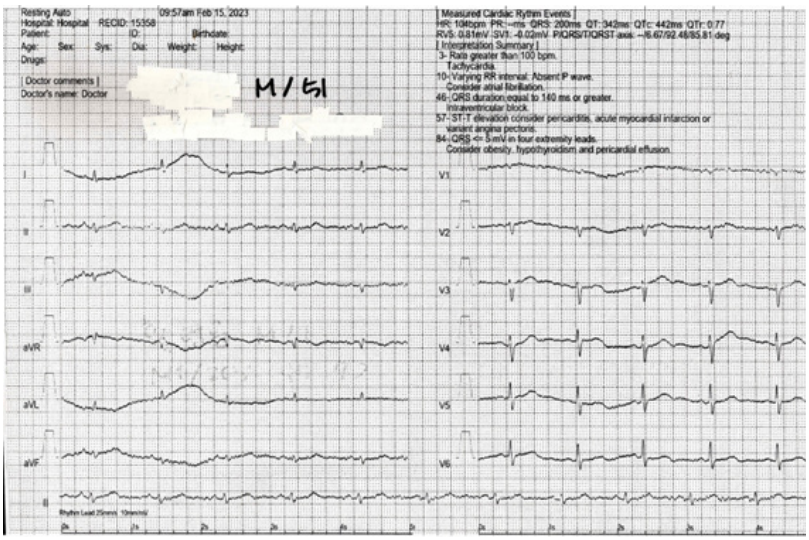

Figure 17A: 51 years old male patient who had variant angina in case 17.

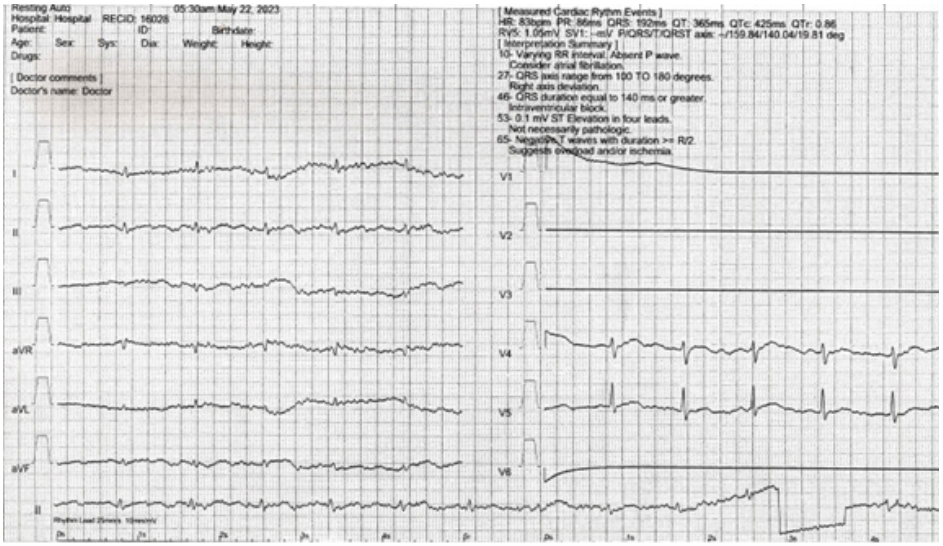

Figure 17B: Had changed to Wenchebach type 2 second degree AV block after exfoliation in case 17.

All the patients were relieved off their symptoms after intravenous injection of 100 ml normal saline mixed with 2 cc Potassium Chloride (KCl) solution for 2 h (for 14-year-old girl, 1 cc KCl solution mixed with 100 ml normal saline), and the ECG recordings were normalized. The most frequent finding (six patients, two of them had ST-segment depression, correlated to the stable angina) of Electrocardiogram (EKG) was anterolateral ST-segment elevation consistent with myocardial infarction. Two of these patients had left ventricular hypertrophy with myocardial infarction. One patient had anterolateral T-segment change (T-inversion). Two patients had QTc prolongation and another two patients had Premature Atrial Contraction (PAC) components. Two other patients had right bundle branch blocks. Ventricular fibrillation (tree patients) and multiform Premature Ventricular Contraction (PVC, one patient), second degree Atrioventricular block (AV block) were observed also. After chemical exfoliation of graphene with NaCl and KCl, the ECG recordings were normalized. Thrombolytic therapy is a major advancement in the management of acute myocardial infarction by intramuscular graphene injection into human body. Thrombolytic therapy works by lysing infarct artery thrombi using the three-dimensional structure of graphene and achieving reperfusion, thereby reducing the infarct size, preserving the left ventricular function, and improving survival. Patient outcomes may be improved with the combined usage of NaCl and KCl. The most important therapeutic goal in the management of acute myocardial infarction is early restoration of complete infarct artery perfusion after the occurrence of an acute coronary occlusion. In the case of chemical exfoliation thrombolysis, the infarct size, hemodynamic status, history of previous infarction, time elapsed since symptom onset, and age of the patient would not be considered against the risk of bleeding. Currently, chemical exfoliation thrombolytic therapy is the only option available to counteract blood clotting induced by the three-dimensional structures of graphene [5,6].

CONCLUSION

The novel therapeutic strategy for graphene-induced blood clotting using chemical exfoliation by NaCl and KCl may achieve long-term benefits at an early stage in patients with an acute cardiovascular disease, including pericarditis, myocarditis, myocardial infarction, and arrhythmia. Significant reduction of infarct size is possible by earlier administration of an effective thrombolytic regimen.

Reocclusion and reinfarction in days or weeks after the acute event may be prevented by colloid gold intake.

CONFLICT OF INTERESTS

There is no conflict of interest.

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