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Case Report

Sepsis, Hypothermia, and the Emergence of Osborn Waves: A Case Report

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Abstract

Hypothermia and sepsis are two serious clinical entities with overlapping presentations, both capable of inducing electrocardiogram (ECG) abnormalities. We present a rare case of a 43-year-old male patient with coincident sepsis, acute kidney injury, and profound hypothermia that was complicated by the development of Osborn (J) waves and conduction abnormalities on the ECG. The patient's core temperature was gradually restored to normal utilizing both passive and active rewarming techniques, resulting in the disappearance of the Osborn wave. Concurrently, his cognitive state and cardiovascular parameters became stable after intensive sepsis treatment. Osborn waves arise from changes in the action potential and ion channel activity between the epicardium and the endocardium. These phenomena can be detected in several medical circumstances, including hypothermia, sepsis, subarachnoid hemorrhage, Brugada syndrome, and acute coronary syndrome. This case highlights the complexity of the diagnosis and management of such clinical scenarios.

Keywords: sepsis, hypothermia, electrocardiogram, Osborn waves, J waves

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1. Introduction

Hypothermia, defined as a body core temperature below 35˚C, affects all body systems, with a more deleterious effect on the cardiovascular and central nervous systems [1]. All phases of hypothermia can lead to various cardiac abnormalities, including alterations in electrocardiogram (ECG) findings [2]. An identifiable feature in this context is the presence of Osborn waves. These waves were first seen by Osborn in the 1950s when studying hypothermic dogs, and have since been documented in the ECGs of both animals and humans [3].

The Osborn wave is a deflection that appears in the ECG as a late delta wave between the QRS complex and the ST segment or as a small secondary R wave in two consecutive beats [4, 5]. These changes were illustrated in several clinical situations. We report a rare case with the coexistence of hypothermia, sepsis, and Osborn waves on the ECG.

2. Case Report

A 43-year-old male presented to the emergency department with poor oral intake and altered mental status. He is known to be hypertensive, a chronic alcohol consumer, to have ethanol-related chronic liver disease, and to be a heavy smoker. On examination, the patient looked cachectic and agitated; his blood pressure was 130/80 mmHg; heart rate was 90 beats/min; body temperature was 36˚C; and respiratory rate was 20 breaths/min. Cardiovascular auscultation was unremarkable. Laboratory parameters revealed leukocytosis 19.83 x 10^3/ml, neutrophils 93%, platelets 106 x 10^3/ml, Hb 15 g/dL, potassium 6.8 mmol/L, creatinine 1019 µmol/L, eGFR 5 mL/min/1.73 m^2, C-reactive protein 201 mg/L, and lactic acid 3.1 mmol/L. At admission, routine 12-lead ECG (Figure **1**) showed sinus tachycardia with no ST-T changes; a chest x-ray showed bilateral diffuse reticulation; and a computerized tomography brain described bilateral old lacunar infarction. Transthoracic echocardiography showed a normal left ventricular ejection fraction, 55% with diastolic dysfunction, grade I. After initial resuscitation, using intravenous fluid and human albumin, he underwent urgent hemodialysis for an acute kidney injury. Empiric antibiotic coverage was started after the withdrawal of urine and blood cultures. During hospitalization, the patient became hypotensive and hypothermic (core temperature 32˚C) due to ongoing septic shock. On follow-up, 12-lead ECG displayed sinus bradycardia, a long PR interval, a prolonged QT interval, and Osborn waves in multiple leads (Figure **2**). In addition to vasopressors to maintain hemodynamics, supportive measures, proper hydration, and passive and active external warming (disposable patient warmer system) were applied. During the next day, the patient's hemodynamics improved, and gradually hypothermia was resolved. Repeated ECG showed an increase in the heart rate, with the disappearance of the camel-hump, Osborn wave (Figure **3**). During the hospital course, the patient's general and mental condition improved with the recovery of renal function after multiple sessions of hemodialysis; simultaneously, inflammatory markers declined, and

sepsis was managed by culture-guided antibiotic coverage. The patient was discharged after 2 weeks in a stable clinical condition.

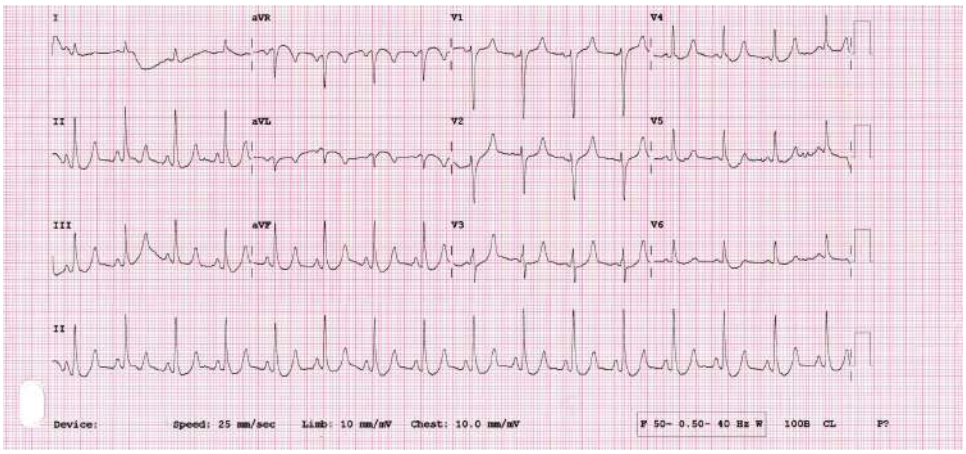

Figure 1: A 12-lead electrocardiogram (ECG) obtained at the time of admission shows sinus tachycardia and nonspecific ST-T changes.

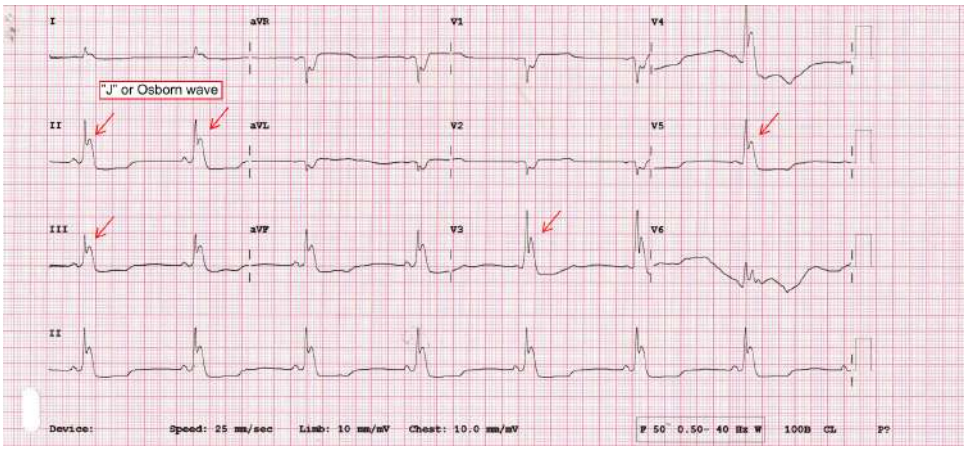

Figure 2: A 12-lead ECG obtained at a core temperature of 32°C, shows sinus bradycardia, prolonged QT interval, and the presence of Osborn waves on the inferior and precordial (V 3- 6) leads.

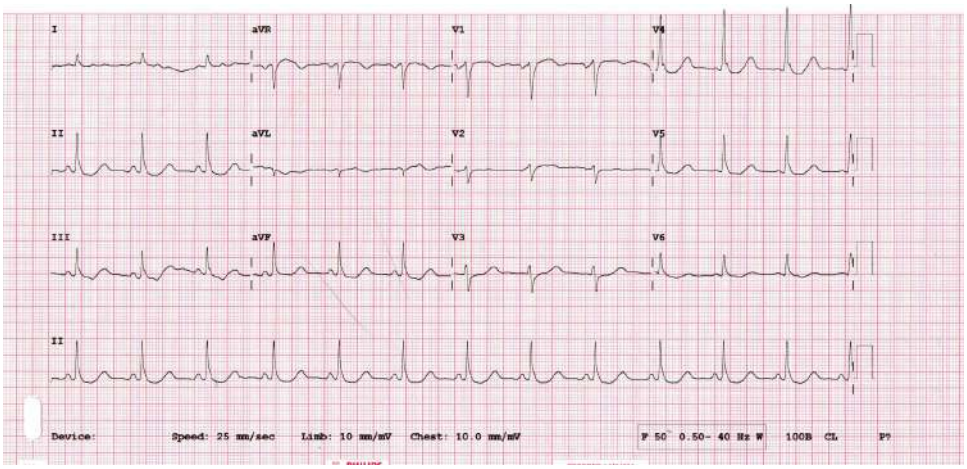

Figure 3: A 12-leads ECG, post-effective warming, with the disappearance of the Osborn waves.

3. Discussion

Hypothermia is a serious medical emergency, defined as a core temperature below 35°C. The simultaneous presence of hypothermia and sepsis poses diagnostic and therapeutic challenges for physicians. Hypothermia is observed in 9–35% of patients with sepsis, and it is independently associated with increased mortality [6, 7]. Moreover, both are capable of inducing ECG abnormalities. Hypothermia can cause several aberrant changes in the ECG, such as prolongation of PR, QRS, and QT intervals, sinus bradycardia, atrioventricular block, ventricular arrhythmias, and Osborn waves [8]. The Osborn "J wave" is produced when the J-point (at the end of the QRS complex and the beginning of the ST segment) is markedly shifted from the baseline. The incidence of hypothermia-associated Osborn waves is reported to be 80% [9]. Our patient exhibited sinus bradycardia and Osborn waves, which, as previously reported, were seen in the inferior and precordial (II, III, aVF, and V3–V6) leads [5]. In both human and experimental studies, the occurrence of Osborn waves, and the temperatures at which it arises, varies greatly. The appearance of an Osborn wave at 25°C was described as 'a current of injury' and correlated to the later onset of ventricular fibrillation [3]. The exact mechanism is not well known, but at the cellular level, it results from alterations in the action potential and ion channel activity, with differences in the transmural gradient between epicardium and endocardium cells generated from excessive epicardium potassium outward current [10]. The Osborn wave is not a pathognomonic sign of hypothermia; it can also be observed in various other medical diseases including acute coronary syndrome, Prinzmetal angina [11], subarachnoid hemorrhage, craniocerebral trauma [12], hypercalcemia [13], Brugada syndrome [14], and takotsubo cardiomyopathy [15].

Our patient demonstrates that sepsis-induced hypothermia can manifest with the Osborn wave; this combination is rarely reported in the literature [16, 17]. In such cases, the autoregulation system behaves differently; the hypothalamic set point for thermoregulation is shifted downward, so the body exerts its cooling effect through peripheral vasodilatation and a decreased metabolic rate. While in exposure, there is an increase in metabolic rate induced by vasoconstriction and shivering [18]. Hypothermia can cause renal tubular dysfunction and intracellular shift, which can lead to electrolyte abnormalities [19]. In our reported case, acute kidney injury responded to renal dialysis sessions and aggressive treatment of sepsis with gradual recovery of kidney function during hospitalization.

Timely recognition and proactive treatment of hypothermia are crucial for optimizing outcomes and reducing mortality. The available treatment options include passive rewarming, which involves covering the patient with an insulating substance, or active rewarming, which can be done either externally or internally [20, 21]. Active exterior rewarming methods may involve using heating pads and forced air-warming systems. On the other hand, active internal rewarming techniques encompass the administration of warmed intravenous fluids, warm fluid lavage, airway rewarming, and advanced extracorporeal blood rewarming [22].

The patient we present, had both passive and active external warming (disposable patient warmer system), resulting in the resolution of Osborn waves and normalization of conduction abnormalities. Subsequently, the patient's overall condition improved, and he was discharged from the hospital.

4. Conclusion

This case underscores the complex relationship between hypothermia, sepsis, and Osborn waves on the ECG. Clinicians should maintain a high index of suspicion for concurrent pathologies in patients presenting with altered mental status and hemodynamic abnormalities, particularly in the setting of systemic infection. Early recognition and intensive management of both hypothermia and sepsis are crucial for preventing serious consequences and reducing mortality in these patients.

Acknowledgment

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Statement of Ethics

The case report was conducted and reported in accordance with the World Medical Association (WMA) Declaration of Helsinki. Ethical approval (Reference No: MOHAP/DXB-REC / J.J.J/No.129/ 2024) was obtained from the Dubai Research Ethics Committee at the Ministry of Health and Prevention.

Patient Informed Consent Statement

Due to the instability of the patient's clinical condition, written informed consent was obtained from his sister for the publication of the case report and the accompanied images.

Conflict of Interest

The authors declare that there is no conflicts of interest.

Artificial Intelligence (AI) Disclosure Statement

AI-unassisted work.

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Author Contribution

Dr Amr Elfaramawy: Contributed to the management of the patient, idea of the manuscript, review of literature, and writing the manuscript.

Dr Ramadan Arafa: Contributed to the management of the patient, review, and adding to the manuscript.

Dr Nehad Alshirawi: Contributed to the management of the patient, and reviewed the manuscript.

Data Sharing Statement

All data collected or analyzed during this study are included in this article. Further inquiries can be directed to the corresponding author.

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