CASE REPORT

Out in the cold: the hypothermic heart response

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SUMMARY

We present an interesting case of a 49-year-old woman with hypothermia and associated Osborn waves (also called J waves) on ECG. She was found on the floor of her home and difficult to arouse. On arrival to the emergency department (ED), her rectal temperature was 87.5°F. ECG showed Osborn waves in diffuse leads. She was intubated in the ED and was started on vasopressor support for hypotension refractory to intravenous fluid boluses. She was transferred to the critical care unit for continued respiratory and cardiovascular support. With active external rewarming her core body temperature continued to improve. Blood pressure also improved and vasopressor was tapered off. She was extubated and was transferred to the medical floor for continued supportive care. Osborn waves on ECG resolved within 12 h of achieving normal range body temperature. The patient was eventually discharged home with medical follow-up.

BACKGROUND

Osborn waves (or J waves) on ECG are considered pathognomonic of hypothermia. They can be alarming for physicians; we present a review to highlight their significance.

CASE PRESENTATION

A 49-year-old woman with a history of coronary artery disease status post-percutaneous intervention of the right coronary artery in 2011, hypertension, diabetes mellitus, chronic obstructive pulmonary disease, depression and anxiety, polysubstance abuse, and chronic benzodiazepine use. She was initially presented to the emergency department (ED) with drowsiness and was offered Narcan for a suspected opiate overdose. She refused this medication and further clinical care and left against medical advice. The next day, she was found on the floor at home by her boyfriend, who had difficulty arousing her. He drove her to our emergency department for assessment. Her initial vitals were blood pressure of 109/55 mm Hg, heart rate 97 bpm, respiratory rate 14 breaths/min and rectal temperature 87.5°F. She was cold to the touch.

INVESTIGATIONS

- ▶ A bedside ECG revealed normal sinus rhythm, rate 62 bpm, intraventricular conduction delay and diffuse J point elevation consistent with Osborn 'J' waves (figure 1).
- ▶ Her urine returned positive for opiates, methadone and benzodiazepines.
- ▶ Serum potassium was 2.9 mEq/L, chloride 109 mEq/L and carbon dioxide 19 mEq/L.
- ▶ Her white cell count was $15.9 \times 10^3/\mu\text{L}$ and she had stable normocytic anaemia with

haemoglobin of 10.9 mg/dL. Her renal function was also stable on admission. Lactic acid was 5.7 mEq/L.

- ▶ Liver function tests included aspartate aminotransferase (AST) 521 U/L and alanine transaminase (ALT) 548 (postadmission increased to AST 1740, ALT 1680 U/L).
- ▶ Acetaminophen and salicylate levels were negative.
- ▶ Bilirubin and alkaline phosphatase had remained normal.
- ▶ Her peak troponin was 1.28 mg/dL, however, it continued to downtrend thereafter.
- ▶ CT and ultrasonography of the abdomen showed a large gallstone, but no obvious cholecystitis or bile duct dilation.
- ▶ Echocardiogram revealed normal left ventricular ejection fraction, chambers dimensions and wall motion. Blood cultures returned negative.

TREATMENT

The patient underwent rapid sequence intubation in the ED. Further post-intubation assessment revealed worsening hypotension to 69/49 mm Hg, which was refractory to fluid support. Vasopressor support was added. She was admitted to the critical care unit for continued support of her respiratory and cardiovascular systems with a focus on preventing further heat loss, rewarming core body temperature and avoiding precipitating ventricular fibrillation or other malignant cardiac rhythms. Cardiac monitors did not reveal arrhythmic activity. Active external rewarming was performed with hot water bottles and chemical packs placed in the axillae, groin and on the abdomen.

OUTCOME AND FOLLOW-UP

With subsequent assessments her core body temperature continued to improve. BP also improved and vasopressor was tapered off. She was extubated and was transferred to the medical floor for continued supportive care. Osborn waves on ECG resolved within 12 h of achieving normal range body temperature. She was eventually discharged home with medical follow-up.

DISCUSSION

Hypothermia is defined as having a core body temperature less than 95°F/35°C. An Osborn wave (or J wave) is a deflection with a dome or hump morphology in the same direction as the R wave, immediately following QRS complex. These waves are considered pathognomonic of hypothermia, manifesting either in selected leads or diffusely,^{1 2} most commonly in inferior and precordial leads V2–V6.³ They

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Figure 1 ECG showing normal sinus rhythm, rate 62 bpm, intraventricular conduction delay and diffuse J point elevation consistent with Osborn 'J' waves.

are detectable in about 80% of hypothermic patients with core body temperature less than 30°C.^{4 5}

Historically, Tomaszewski⁶ provided the first description of hypothermic J waves in an accidentally frozen man. Their pathophysiology was further elucidated by Dr John Osborn in 1953, hence the term 'Osborn waves', in recognition of his landmark work.⁷

The proposed cellular mechanism for the appearance of Osborn waves during hypothermia is the development of a transmural voltage gradient across the ventricular wall during ventricular activation. This voltage gradient between epicardial and endocardial cells develops because of accentuated transient outward potassium current (Ito) in epicardial cells that does not occur in the endocardial cells, resulting in the appearance of Osborn waves at the end of the QRS complex.^{8–11}

Some other conditions producing Osborn waves include Brugada syndrome, hypercalcaemia, brain injury and early repolarisation syndrome.^{12–14}

Osborn waves become more prominent with decreasing body temperature but regress gradually with rewarming.¹⁵ Other than Osborn waves, sinus bradycardia, prolonged PR and QT intervals, and atrial fibrillation can also be detected in hypothermic patients.¹⁶

With core body temperature less than 30°C/86°F, a progressive widening of the QRS complex increases the risk of ventricular tachycardia/fibrillation (VT/VF).¹⁷ When the temperature drops to ~15.5°C/60°F, asystole ensues.

Competing interests None.

Patient consent Obtained.

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Learning points

- Osborn or J waves are detectable in about 80% of hypothermic patients with core body temperature less than 30°C, most commonly appearing in inferior and precordial leads V2–V6 and regressing gradually with rewarming.
- They are produced because of a transmural voltage gradient across the ventricular wall, due to accentuated transient outward potassium current (Ito) in the epicardial cells, which does not occur in the endocardial cells.
- Some other conditions producing Osborn waves include Brugada syndrome, hypercalcaemia, brain injury and early repolarisation syndrome.
- There is increased risk of ventricular tachycardia/fibrillation (VT/VF) with progressive QRS widening.

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