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Intraoperative accidental hypothermia as a probable cause of malignant ventricular arrhythmias in an elderly patient undergoing transurethral resection of prostate: A case report

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ABSTRACT

Background: Intraoperative hypothermia is a common but severe condition that is defined as a core body temperature below 36 °C. Accidental hypothermia can produce coagulopathy, immunosuppression and peripheral hypoperfusion that can ultimately lead to life-threatening ventricular arrhythmias and vital organ injury, and it is significantly associated with perioperative complications and mortality.

Case description: We report the case of an 82-year-old man who presented with persistent ventricular tachycardia intraoperatively due to accidental hypothermia. The patient was diagnosed with benign prostatic hypertrophy and scheduled for transurethral resection of the prostate. Laboratory tests showed moderate anemia, and echocardiography indicated mild tricuspid and mitral regurgitation. The patient received general anesthesia with endotracheal intubation. Four hours after the start of surgery, the patient developed sudden ventricular tachycardia with severe hypotension. Arterial blood gas sampling indicated that there was no disturbance of electrolytes, acid-base balance or excessive bleeding. The rectal temperature was measured immediately, and the core temperature was 32 °C. The patient received antiarrhythmic therapy and rewarming measures. No additional ventricular arrhythmias appeared after the core temperature rose to 35 °C and the blood pressure returned to normal. The patient was transferred to the intensive care unit after surgery for further observation and was moved to the general ward the next day. He was discharged 4 days later without significant organ damage.

Conclusions: Intraoperative hypothermia may increase ventricular arrhythmia risk, especially in elderly patients. Surgeons and anesthesiologists should pay more attention to preventing and reversing accidental hypothermia, necessitating aggressive efforts to maintain normothermia during surgery.

Abbreviations: ASA, American Society of Anesthesiologists; CPR, Cardiopulmonary resuscitation; DOR, Dispersion of repolarization; ECG, Electrocardiograph; TURP, Transurethral resection of prostate; ICU, Intensive care unit; MAP, Mean arterial blood pressure; OR, Operating room; VT, Ventricular tachycardia.

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1. Introduction

Transurethral resection of the prostate (TURP) is the standard surgical treatment for benign prostatic hyperplasia, and has been confirmed as a safe procedure [1]. One of the important perioperative complications that cannot be ignored during TURP is hypothermia, which is also a frequent observation in other surgical patients under general anesthesia [2]. Large amounts of unwarmed irrigating fluids can cause a significant reduction in core body temperature, and severe intraoperative hypothermia (core body temperature <28 °C) may threaten patient safety, with a significant mortality rate of 25–40% [2,3]. The potential adverse effects of hypothermia include myocardial injury, coagulopathy, delayed drug metabolism, and hemodynamic imbalance [2]. If persistent hypothermia is not corrected in time, the patient will develop malignant ventricular arrhythmias (e.g., ventricular tachycardia (VT)) and even cardiac arrest. Meanwhile, hypothermia has been shown to be neuroprotective and improve survival after cardiac arrest in previous studies [4]. Recent research has demonstrated that whether hypothermia has protective or harmful effects depends on its duration and depth [5]. Here, we report that a patient with accidental hypothermia developed ventricular arrhythmia during surgery. We present the following case in accordance with the CARE reporting checklist.

2. Case presentation

An 82-year-old man was diagnosed with benign prostatic hypertrophy with a chief complaint of dysuria and then scheduled for TURP in our institution. At admission, we found no significant abnormalities in the patient's general physical and electrocardiogram (ECG) examinations. Laboratory tests showed normal results except for moderate anemia (hemoglobin 8.6 g/dL). Echocardiography indicated mild tricuspid and mitral regurgitation with normal left ventricular function (ejection fraction: 68%). The patient had no prior history of coronary artery disease or arrhythmia. Although living with family, he was able to perform most activities of daily living independently.

Upon admission to the operating room (OR), standard monitoring was used. The patient subsequently received general anesthesia with endotracheal intubation according to a standard protocol as previously reported [6]. After anesthesia, a 22-gauge catheter was inserted into the left radial artery for continuous monitoring of arterial blood pressure and blood gas, and then the patient was placed in the lithotomy position for TURP. At the start of the surgery (02:40 p.m.), all vital signs were stable, with a sinus rhythm of 70 bpm and a mean arterial blood pressure (MAP) of 79 mmHg. Four and a half hours later (07:11 p.m.), the patient developed sudden VT (heart rate 160 bpm) with severe hypotension (MAP 59 mmHg). The monitor showed changes in vital signs and ECG parameters before the onset of VT (Fig. 1A), the onset of VT (Fig. 1B) and after the termination of VT (Fig. 1C). Immediately, the procedure was stopped, and we started antiarrhythmic therapy, including cardiopulmonary resuscitation (CPR) and vasoactive drug infusion, to maintain sinus rhythm and stable circulation. The arterial blood gas indicated that there was no disturbance of electrolytes, acid-base balance or excessive bleeding. Intraoperative arterial blood gas analyses at different time points are presented in Table 1. Core body temperature (rectal temperature) was measured immediately, and the initial temperature was 32 °C. The monitor showed that the core body temperature fell to a minimum (31.5 °C) within 10 minutes at 07:10 p.m. and then gradually rose. Necessary measures (warmed IV fluids and forced-air warming) were applied to maintain normothermia (up to 37 °C at 10:00 p.m.). Intraoperative core body temperature, heart rhythm and emergency treatment are summarized in Fig. 2. No additional ventricular arrhythmias appeared after the

Fig. 1. An overview of cardiac arrhythmia interventions and core body temperature change during surgery. Abbreviations: VT, ventricular tachycardia.

core temperature rose to 35 °C and the blood pressure returned to normal.

The patient was transferred to the intensive care unit (ICU) after surgery, and vital signs (core temperature, ECG, blood pressure, heart rate, oxygen saturation and respiratory rate) were continuously monitored. The next day, the patient was moved to the general ward with stable signs. He was discharged on Day 4 without significant organ damage or neurological abnormalities. Written informed consent was provided by the patient's legal guardian for the publication of this case report, and the guardian consented to publication of their unidentifiable data and images.

3. Discussion

Here, we report the case of an elderly patient who presented with persistent ventricular arrhythmias during TURP, mainly induced by accidental hypothermia. When an arrhythmia is complicated by severe hypotension, immediate management is crucial to avoid more serious consequences. It is important to ensure cardiac rhythm and hemodynamic stability to restore effective peripheral tissue perfusion and maintain cellular metabolism. Accidental hypothermia is a frequent condition in ORs, and maintaining normothermia is challenging for surgical, anesthetic and nursing teams. We confirm that careful monitoring and prompt treatment are necessary and effective for patient safety.

Arrhythmia is a common cardiovascular complication in surgical patients under general anesthesia with an incidence of 70% as reported in recent studies [7]. Severe arrhythmia is clinically important because it can cause hemodynamic instability. In general, there are three main aspects that may contribute to intraoperative arrhythmia, including the patient, surgery, and anesthesia. Compared to younger patients, elderly patients are more susceptible to atrial fibrillation. Patients with preexisting cardiac disease have a higher incidence of intraoperative arrhythmia and sudden cardiac death than those without. Due to frequent stimulation of the autonomous nervous system, specific types of surgeries (e.g., cardiac and dental surgery) have a high risk of ventricular arrhythmia. Factors associated with anesthesia, including anesthetic agents, endotracheal intubation, and central venous cannulation, are likely to induce arrhythmia. Abnormal blood gas or electrolytes, hypoxia, carbon dioxide retention and hypothermia can also result in arrhythmia. It is noteworthy that resuscitation from hypothermia-induced cardiac arrest is difficult and often takes longer than cardiac arrest induced by other factors [8].

As previously reported, hypothermia was defined as a core body temperature below 36 °C [9], and it can be classified into three categories based on the decrease in body temperature: mild (32–36 °C), moderate (28–32 °C), and severe hypothermia (<28 °C) [10]. Based on the above criteria, our patient was classified as having moderate hypothermia with a lowest core temperature of 31.5 °C. Complications related to accidental hypothermia include increased transfusion, coagulation disorders, wound infections, and cardiac arrhythmia. In addition, drug metabolism is significantly reduced during hypothermia, and the effect of anesthetic agents is prolonged in patients under general anesthesia [9]. Another adverse effect of hypothermia is uncontrolled shivering, especially in patients undergoing cesarean section [11]. Shivering during surgery can increase oxygen consumption and bring patients an unpleasant experience.

Potential pathophysiological mechanisms have been proposed to explain the association between hypothermia and arrhythmia. To our knowledge, hypothermia can affect ventricular repolarization, prolonging the action potential duration and QT interval. Filippi and colleagues [12] have revealed that lower temperatures can significantly change the time constants of ionic channels in cardiac myocytes, which further leads to the alteration of the dynamics and excitability of electrical waves. Interestingly, Piktel et al. [13] reported that transmural dispersion of repolarization (DOR) may play a vital role in hypothermia-induced arrhythmogenesis. Moreover, the degree of arrhythmia susceptibility is likely to be directly correlated with the degree of elevated DOR.

Many studies have demonstrated that several risk factors are associated with an increased incidence of hypothermia, including the individual patient, type of anesthesia, surgery, drugs used and the environment [4,9,11]. Specifically, risk factors include age ≥60 years old, low body mass index, diabetes mellitus, hypothyroidism, ASA grade ≥ II, the use of large volumes of unwarmed irrigation fluids and a low temperature in the OR. In the present case, the cause of accidental hypothermia was most likely multifactorial, as the patient had 3 or more risk factors mentioned above. Due to the high incidence of hypothermia during surgery, more attention should be

Table 1
Change in arterial blood gas variables during surgery. T0: baseline; T1: 60 minutes before the first episode of VT; T2: the first episode of VT; T3: 30 minutes after multiple episodes of VT; T4: before the patient left the operating room. Abbreviations: pO2, partial pressure of oxygen; pCO2, partial pressure of CO2; SaO2, oxyhemoglobin saturation; Hb, hemoglobin; Hct, hematocrit; $HCO3^-$, bicarbonate.

Variables	T0	T1	T2	T3	T4
pH	7.376	7.318	7.305	7.314	7.414
pO2, mmHg	515	182	68.5	444	440
pCO2, mmHg	36.5	40.6	41.0	49.3	47.0
SaO2	100.6	99.2	91.1	99.6	99.7
Hb, g/dL	7.8	7.4	6.7	7.5	8.3
Hct, %	24	22.6	20.4	19.3	25.6
Potassium, mmol/L	3.8	4.0	4.4	3.3	3.9
Sodium, mmol/L	140	139	139	142	140
Glucose, mmol/L	6.8	8.7	8.9	11.3	8.2
Lactate, mmol/L	0.4	0.6	0.7	1.6	1.3
$HCO3^-$, mmol/L	26	24.2	23.5	27.4	28.9

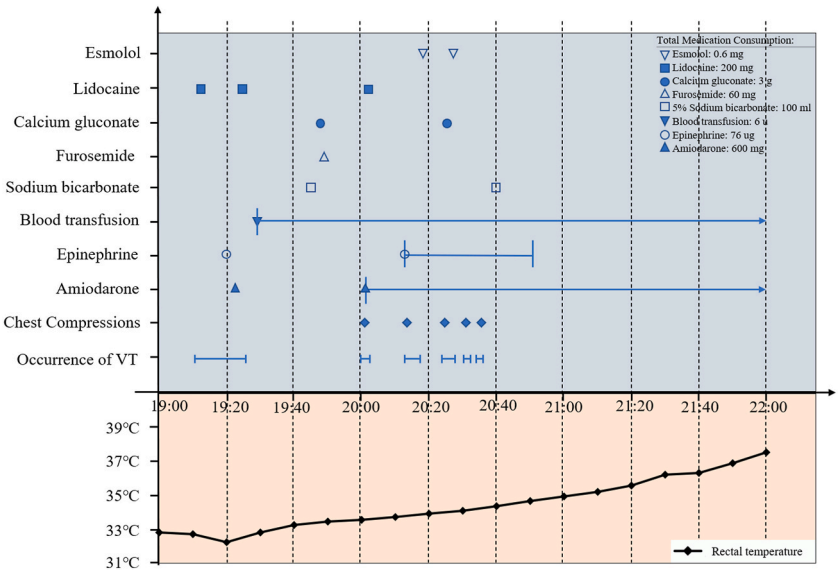

Fig. 2. Intraoperative pictures of monitor which showed the patient's vital signs change. A: before the onset of VT. B: the onset of VT. C: after the termination of VT. Abbreviations: VT, ventricular tachycardia.

given to preventing hypothermia and maintaining body temperature in the OR [9,11]. The possible preventive measures of intraoperative accidental hypothermia can be classified as follows: 1) prewarming of the patient (e.g., convective) before general anesthesia that decreases the heat loss due to redistribution; 2) active warming of the patient during surgery that transfers heat to the patient, such as active body surface warming systems, warmed infusions or blood products, warming of irrigation fluids, and anesthetic gases warming; and 3) passive warming of the patient to reduce excessive radiating and convective heat loss during surgery, such as maintaining a normal OR temperature and covering as much of the exposed body surface as possible. To decrease the incidence of accidental hypothermia and prevent perioperative complications, each patient's core temperature will be monitored every 5 minutes during surgery in our institution. Meanwhile, we are conducting a large retrospective study to determine the risk factors for intraoperative accidental hypothermia in the Chinese population. We will present a prediction model that can provide an individualized estimate of the risk of intraoperative hypothermia. Once identified, more essential preventive measures will be applied for high-risk patients to maintain normothermia during surgery.

4. Conclusion

Multiple factors contribute to intraoperative hypothermia in patients undergoing TURP, especially in elderly patients, leading to increased ventricular arrhythmia risk. Surgical, anesthetic and nursing teams should pay more attention to prevent and reverse accidental hypothermia.

Author contribution statement

All authors listed have significantly contributed to the investigation, development and writing of this article.

Data availability statement

Data will be made available on request.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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