USE OF AN IMPEDANCE THRESHOLD DEVICE TO TREAT SEVERE HYPOTENSION IN A PREGNANT WOMAN: CASE REPORT AND REVIEW OF THE LITERATURE

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Abstract—Background: Impedance threshold device technology harnesses the patient’s normal physiological mechanisms to increase circulation during hypotensive crises. We report the first clinical use of one version of this device on a spontaneously breathing hypotensive pregnant woman. Objective: The objective of our study was to report this case to help Emergency Medical Service rescue personnel to noninvasively treat hypotensive but conscious spontaneously breathing patients. Case Report: A 28-year-old woman who was 21 weeks pregnant developed frank syncpe at home but recovered spontaneously. When Emergency Medical Service paramedics arrived, her initial blood pressure and heart rate were 115/80 mm Hg and 125 beats/min, respectively. She suddenly complained of feeling anxious and developed profound bradycardia and hypotension, followed by 20 s of asystole. An impedance threshold device (ResQGARD™) with $7\text{cmH}_2\text{O}$ resistance to inspiration was rapidly applied using a facemask. After four spontaneous breaths, blood pressure increased from 62/40 mm Hg to 106/66 mm Hg. She was hemodynamically stable thereafter. Conclusions: In this case report, the multiple physiological effects of inspiration through $7\text{cmH}_2\text{O}$ resistance helped this pregnant hypotensive patient to rapidly and noninvasively restore adequate perfusion and reduced the duration of her hypotensive episode. To our knowledge, this is the first report of this technology in a pregnant hypotensive but spontaneously breathing patient. © 2013 Elsevier Inc.

Keywords—pregnancy; impedance threshold device; cardiovascular collapse; hypotension

INTRODUCTION

Impedance threshold device technology harnesses a patient’s normal physiological mechanisms to increase circulation during hypotensive states. We report the case of a spontaneously breathing pregnant woman suffering a sudden and severe case of hypotension with extreme bradycardia treated with an impedance threshold device (ITD-$7\text{cmH}_2\text{O}$). To our knowledge, this is the first clinical report of the use of this device in a pregnant patient. The data sources were the Emergency Medical Service (EMS) record and the hospital file of the patient. The Institutional Review Board waived the need for informed consent.

CASE REPORT

A 28-year-old woman was previously diagnosed with postural tachycardia syndrome. She was 21 weeks pregnant with her second child: her first pregnancy was uneventful. On the morning of the current episode, she developed frank syncope and fell to the floor. Her family
called 911. The Advanced Life Support team found a conscious woman, without any distress, lying on her bed. She reported neck and back pain at the T4–5 level, as well as right knee pain. Her blood pressure was 115/80 mm Hg, her heart rate 125 beats/min, and the electrocardiogram (ECG) showed a normal sinus rhythm. A neck brace was placed and she was transported to the ambulance on a back board. Before the ambulance started to move, she suddenly complained of feeling anxious; the monitor showed the abrupt onset of bradycardia and hypotension, followed by 20 s of asystole. Left lateral positioning of the patient did not improve her status. An ITD-7 cmH2O (ResQGARD™, Advanced Circulatory Systems, Inc., Roseville, MN) was rapidly applied using a facemask. After less than four spontaneous breaths, blood pressure increased from 62/40 to 106/66 mm Hg. An i.v. line was inserted and the patient received a normal saline solution at a rate of 1000 mL/h. The ECG rhythm strip revealed normal sinus rhythm at a rate of 98. She next complained that the facemask felt like it was very difficult to breathe, but she was instructed to continue to take slow deep breaths through the low level of inspiratory resistance created by the ITD-7. She continued to complain that she felt like she was suffocating. As she was hemodynamically stable, rescue personnel decided to remove the ITD-7 under close monitoring. Her blood pressure immediately decreased from 105/65 to 65/42 mm Hg. The ITD-7 was reapplied and after a couple of breaths blood pressure again rose to 105/70 mm Hg. Upon arrival at the Emergency Department, the ITD-7 was removed and the patient remained stable. In total, she had received 500 mL of a saline infusion and a 30-min treatment with the ITD-7. There were no known or reported immediate complications from ITD-7 use in this pregnant patient. No spinal injury was found. The patient developed bradycardia and hypotension for unclear reasons. She was hospitalized for 3 days in a telemetry ward and was stable. Her baby was born, at term, without complications. The hypotension and bradycardia were thought to be most likely secondary to a vasovagal event associated with her earlier diagnosis of postural hypotension, some relative dehydration, and supine hypotension syndrome of pregnancy.

**DISCUSSION**

The acute treatment for hypotension during a vasovagal event is to place the patient supine and, if symptoms persist, begin administration of a fluid therapy such as normal saline solution. In the case of a pregnant hypotensive patient, the supine position can be associated with a reduction in venous return, relative central hypovolemia, and hypotension. In this case report, the pregnant patient was treated acutely, noninvasively, and rapidly (before i.v. line placement) with an ITD-7 designed to increase circulation by a physiologic mechanism similar to a Mueller maneuver (1). The ITD is designed with a valve that closes when the pressure within the thorax is less than atmospheric pressure, and a second valve that opens at a preset negative intrathoracic pressure of $-7 \text{ cmH}_2\text{O}$, thereby creating a resistance during inspiration. Supplemental O2 can be delivered with the ITD-7. The ITD-7 is U.S. Food and Drug Administration approved. A recent study showed the feasibility, effectiveness, and safety of rapidly deploying the ITD by first responders to treat hypotension secondary to blood loss and trauma in the urban setting by EMS personnel (2). Use of the ITD-7 was recently thoroughly reviewed (3). It is important to note that this device is different in design from the ITD used to increase circulation in patients undergoing cardiopulmonary resuscitation. Indications, contraindications, and discontinuation criteria of the ITD-7 have been described previously by Convertino et al. (3).

The first ITD was originally designed to improve circulation during cardiopulmonary resuscitation after cardiac arrest (4,5). Additional research and a small change in design, e.g., reducing the inspiratory impedance to $-7 \text{ cmH}_2\text{O}$, has resulted in a new and different device that provides a way to harness the thoracic pump to enhance circulation in spontaneously breathing patients. The new device, called the ITD-7 or ResQGARD, enhances the duration and magnitude of the intrathoracic vacuum with each inspiratory effort (4,6,7). The negative intrathoracic pressure generated during each inspiration draws more blood back into the heart, resulting in an immediate increase in stroke volume, cardiac output, and systolic/diastolic blood pressure in both animal models of hypotension and hypotensive patients (6–11). This intrathoracic vacuum, relative to the rest of the body, is also instantaneously transmitted to the brain by the veins surrounding the spinal column and perhaps through the cerebrospinal fluid via the intervertebral foramina (12). The ITD-7 has been studied in hypotensive swine and hypotensive humans (6–11,13–16). In randomized blinded studies, the ITD-7 has been demonstrated to reduce hypotension (9,14,15). It has also been used clinically to treat orthostatic intolerance and hemorrhagic shock (7–9, 11,15). ITD use has also been shown to improve short-term and 24-h survival of hemorrhagic shock (7,13). One important characteristic of the ITD is that it can “buy time” until more definitive treatment is available (9,8).

In our case report, these multiple physiological effects helped this pregnant hypotensive patient to rapidly and noninvasively restore adequate perfusion and reduced the duration of her hypotensive episode. To our knowledge, this is the first report of this technology in a pregnant hypotensive but spontaneously breathing patient. The
ITD is a new noninvasive tool to rapidly treat hypotensive patients that is particularly useful when i.v. access and fluids are not readily available for the treatment for hypotensive situations. It buys time for the patient to be transported to a medical or surgical team or for EMS to realize a definitive treatment. Use of the ITD should be encouraged in EMS services.

CONCLUSIONS

The ITD was an effective tool in our pregnant patient who developed hypotension secondary to vasovagal syncope; it provides an effective, rapid, and safe therapy to help improve hemodynamics and restore adequate circulation, especially when fluid resuscitation is not readily available.

REFERENCES