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Clinical Column

Trendelenburg position in hypovolemic shock: A review

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A patient develops sepsis from an infected endovascular graft. A second patient presents to the emergency department with a suspected aortoiliac injury from blunt abdominal trauma. Both of these vascular emergencies have a common link: a strong likelihood for the development of hypovolemic shock. In many facilities, positioning of a patient supine with the head down and legs above the level of the heart (known as the Trendelenburg position) remains among early interventions used by health-care providers to treat hypotension from suspected hypovolemia. Is this position still an appropriate adjunctive therapy to treat hypovolemic shock or is it a myth? What are the potential adverse effects of its use? The purpose of this clinical column is to review the use of the Trendelenburg position (TP) in hypovolemic shock to answer these questions.

BACKGROUND

Shampo[1] noted that the Roman writer Celsus (25 BC-20 AD) described the use of an inclined position in the treatment of abdominal injuries. The Dutch surgeon Abraham Cyprianus in 1694 used a head-down, leg elevation technique during a laparotomy.[2] However, this position has been credited to the German surgeon Friedrich Trendelenburg who, in the 1880s, used the technique he called the "Beckenhochlagerung" or raised pelvic position with knees bent and hanging over the edge of the table in pelvic surgeries.[3] The purpose of the positions was for displacement of the abdominal and pelvic viscera to improve surgical exposure.

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It was in World War I that Walter Cannon, an American physiologist, championed the Trendelenburg position during the resuscitation of hemorrhagic shock.[4,5] Its purpose was an antishock maneuver. The physiologic theory behind the Trendelenburg position was that an increase in venous return would occur by a change in the hydrostatic gradient, with the legs elevated above the level of the heart and the head down. Through the Frank-Starling mechanism, this augmentation in venous blood return from the extremities and abdomen would subsequently increase the stroke volume and cardiac output, thereby improving perfusion to vital organs such as the brain and heart.[6] In essence, the assumption was the TP increases blood volume to the thorax and brain via an autotransfusion effect. Cannon rescinded his opinion on Trendelenburg position approximately 10 years later, but its popularity remained.[5]

RESEARCH FINDINGS

Early research on 60 rats in a 30° head down, 30° head up, and horizontal position after a controlled hemorrhage was induced through femoral artery cannulation.[7] The rats were assigned into one of the 3 groups after hemorrhage, and survival was measured in increments up to 24 hours after procedure. Eighty-three percent of the animals died in the head-down position, 50% died in the head-up position, and none died in the horizontal position.[7]

Bivins et al[8] examined 10 healthy volunteers that were placed in the Trendelenburg position. Blood volumes were determined from the body surface area, and radionuclide scanning was used to determine blood volume distribution. Results revealed a 1.8% displacement of the total volume centrally, which was felt to be clinically insignificant.[8]

A study of the hemodynamic effect of 15–20° head-down tilt in 61 normotensive and 15 hypotensive patients with acute cardiac illness or sepsis was conducted by Sibbald.[9] The measurements included preload, afterload, blood pressure, and cardiac output. Results did not demonstrate any beneficial hemodynamic effect of the TP in these patients.[9]

Ostrow et al[10] examined the effect of Trendelenburg and modified Trendelenburg positions on cardiac output, cardiac index, mean arterial pressure, systemic vascular resistance, and oxygenation in 23 cardiac surgery patients. Both 10° and 30° modified TP were used. Results revealed no statistically significant variations in all five variables.[10]

The use of the Trendelenburg position in resuscitation was reviewed by Bridges and Jarquin-Valdivia.[11] Eight small nonrandomized cohort studies were ultimately included in this 2005 summary. The studies were mixed, containing a variety of hypotensive etiologies with small samples. The authors concluded that the research on the hemodynamic effects of the TP in treating hypovolemic shock was small and did not reveal beneficial or sustained changes in systolic blood pressure, preload, afterload, or cardiac output.[11]

A second review published by Geerts[12] examined the use of TP or passive leg raising (PLR) in the treatment of hypovolemia. The purpose was to determine which position had the best effect on cardiac output within 10 minutes of a postural change from the supine position. Twenty-one studies on PLR (n = 431) and 13 studies on TP (n = 246) were included in this 2012 review. TP was defined as a total body head-down tilt of 5–60°, and PLR was defined as a supine position with both legs elevated at a 10° to 90° angle. The summary revealed that although both TP and PLR increased cardiac output, only PLR was able to sustain the increase after 1 minute, whereas the cardiac output while in the TP decreased between 2 and 10 minutes.[12]

Twenty studies of clinical effects of TP and PLR on cardiac output/cardiac index and blood pressure were summarized in a clinical review by Halm.[13] The studies were small and included both animals and humans. Study numbers were not specified. The human studies consisted of healthy and critically ill patients. The TP tilt and PLR were not specified. Many studies were observational. Results revealed that the cardiac output and cardiac index did increase with both TP and PLR, but the elevation was transient, lasting 1–5 minutes. There was no change in blood pressure with either position.[13] Secondary TP clinical indices results included an increase in preload (via increased central venous pressure and pulmonary artery pressure) and decrease in cerebral blood flow/perfusion pressure, oxygen saturation, and jugular vein velocity.[13]

Ostrow[14] surveyed critical care nurses about their use, their knowledge, and the effectiveness of the Trendelenburg position. Ninety-nine percent of the respondents used TP for the treatment of hypotension or for placement of a central venous catheter. Information on TP was received either through nursing education or through the workplace. TP was considered to be beneficial in the treatment of hypotension by 80% of the responders.[14] This study was published in 1997. Informal discussions with nurses in 2018 by this column's author revealed the same beliefs and attitudes toward TP.

ADVERSE EFFECTS

Adverse effects of TP were noted as early as 1956 when Hewer[15] reported the potential for retinal detachment, decreased vital capacity, increased airway secretions, and aspiration of gastric contents with TP use during surgery. A survey of US anesthesiologists by Souki et al[16] on steep TP use (30° to 45° head-down tilt) during surgery included any complications experienced. Complications were reported by 63 of 290 (21.7%) respondents. The most common complications included airway and face edema, brachial plexus injury, and corneal abrasions. Less common injuries among others were visual loss or defects and respiratory problems (not specified).[16]

TABLE 1

POTENTIAL ADVERSE EFFECTS OF THE TRENDELENBURG POSITION

- Facial/laryngeal edema
- Anxiety/restlessness
- Hypoventilation/atelectasis
- Altered ventilation-to-perfusion ratio
- Increased intracranial pressure
- Increased airway secretions
- Aspiration of gastric contents
- Increased intraocular pressure
- Brachial plexus injury
- Decrease in lower extremity arterial blood flow
- Cardiac arrhythmias

Intraocular pressures and transcranial ultrasound pulse amplitudes, an indirect measurement of intracranial pressure, significantly increased in a 15° head-down tilt position compared with those in a supine position in 15 healthy subjects.[17] This elevation in intracranial pressure from an increase in venous flow from blood outside the cranium is a potential adverse effect in patients with an underlying head trauma or other cranial pathology.[11] A decrease in lung volumes related to the shifting of the abdominal contents toward the diaphragm may result in atelectasis, hypoventilation, or alteration in ventilation-perfusion ratios, especially in patients with a high body mass index or a history of pulmonary disease.[18] Anxiety, fear, dyspnea, and position intolerance by the patient may occur.[12] Prolonged leg elevation in patients with severe peripheral artery disease may impact the lower extremity perfusion from a decrease in segmental blood flow.[19] In patients with coronary artery disease, cardiac arrhythmias may develop from an increase in myocardial oxygen consumption from the TP position.[13] The longer the TP is maintained, the higher the risk for an adverse effect to occur. The presence of concomitant comorbidities such as cardiovascular, pulmonary, or neurological diseases may contribute to the incidence of adverse effects. Table 1 summarizes the adverse effects of TP.

SUMMARY

For many years, research has not supported TP as an adjunctive treatment in the treatment of hypovolemic shock; this practice is a myth. Current recommendations for shock positioning are having the patient supine with the legs passively elevated at 30° to 60° if there is no evidence of trauma or injury (such as simple fainting, shock from nontraumatic bleeding, sepsis, dehydration).[20] However, TP remains appropriate for many surgeries (such as robotic and gynecologic procedures) in addition to jugular or subclavian central line placement.[21–23] The continued use of TP in hypovolemic shock cases despite the negative research findings is most likely multifactorial and includes elements of tradition and a knowledge deficit of what is considered the best practice.

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