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Case Report

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The Application of Ultrasound-guided Peripheral Venipuncture in the Rescue of Hemorrhagic Shock during Operation - A Case Report

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Abstract

Compared to traditional peripheral venous puncture, ultrasound-guided venous puncture has a higher success rate and fewer complications. In this case, the ultrasound-guided puncture technique successfully established two peripheral venous channels for fluid rehydration, despite the surgical position limiting the field of view and scope of the scan and circulatory failure. Ultrasound-guided peripheral venous puncture can save time for patients with hemorrhagic shock and help form a more effective rescue strategy.

Keywords

Ultrasound-Guided Venipuncture, Hemorrhagic Shock, Peripheral Venous Access, Anesthesiology, Vascular Puncture

Introduction

The ultrasound-guided vascular puncture technique was initially used for radial artery puncture catheterization and later widely adopted for arteriovenous puncture catheterization. Research indicates that complications from ultrasound-guided venipuncture, such as vascular injury, local hematoma, or pneumothorax formation, are significantly lower compared to traditional puncture techniques [1]. The high success rate of the first puncture makes it a recommended approach for deep venipuncture catheterization [2]. The development of ultrasound-guided vascular puncture technology has also expanded its application scope, particularly for children with puncture difficulties and obese patients [3,4]. Clinical studies in these groups have also yielded significant results.

Because of the advantages of ultrasound-guided visualization and real-time guidance, this technology has become an increasingly effective diagnostic tool for anesthesiologists who encounter various intraoperative emergencies, such as hypotension, hypoxemia, and the creation of different access routes.

Case Report

A 68-year-old female (height 163 cm, weight 60 kg) was hospitalized for more than three years due to the discovery of a mass in the upper lobe of the right lung during a physical examination and was scheduled to undergo surgical treatment. Preoperative examinations, including an electrocardiogram, chest computed tomography, blood cell analysis, and coagulation function examination, were completed, and thoracoscopic right upper lobe resection was planned after contraindications for surgical anesthesia were excluded.

Routine monitoring of the electrocardiogram, oxygen saturation, blood pressure, and end-tidal carbon dioxide was conducted upon the patient's arrival in the operating room. An infusion route was established in the patient's right radial veins, and 500 ml of sodium lactate Ringer injection was administered intravenously. Routine induction of anesthesia was performed, with intravenous injections of 15 μg of sufentanil, 3.75 mg of remimazolam, 5 mg of vecuronium, and 18 mg of etomidate. An ID-32 visible double-lumen bronchial catheter was successfully inserted with the patient in the left lateral position. Invasive arterial blood pressure was monitored by puncture catheterization of the left radial artery. The patient's surgical position was left lateral.

During the operation, while freeing the right superior lobar bronchus, there was no clear boundary between the right superior lobar lymph nodes and the posterior ascending branch artery. Hemorrhage from the posterior ascending branch artery during the separation process was challenging to control under a thoracoscope, and the patient experienced a progressive drop in blood pressure, down to 42/20 mmHg, followed by no readings from arterial blood pressure monitoring. The rescue process began immediately, with the surgeon proceeding to open the chest to relieve the pressure and stop the bleeding. Simultaneously, 20 μg of norepinephrine and 10 μg of epinephrine were administered intermittently, along with accelerated fluid reinfusion via established venous channels in the left saphenous vein and left median antebrachial vein, respectively, using the single-operator, dynamic short-axis technique. After treatment with vasoactive drugs, rapid blood volume supplementation, ice cap brain protection, and surgical hemostasis, the patient's blood pressure rose after about 10 minutes, reaching 180/92 mmHg. The patient's heart rate ranged from 76 to 118 beats per minute. The minimum end-tidal carbon dioxide was approximately 20 mmHg, and peripheral oxygen saturation gradually increased to 99% as blood pressure improved. Norepinephrine (0.1 μg/kg/min) was continuously infused to maintain circulation, and suspended red blood cells and plasma were transfused to replenish blood volume. The operation continued, and norepinephrine infusion was gradually reduced and stopped based on the patient's blood pressure level.

The surgery lasted approximately 226 minutes. The patient received 9.5 units of suspended red blood cells, 1000 ml of fresh frozen plasma, 300 ml of self-recovered blood, 3950 ml of crystalloid fluid, and 1500 ml of colloidal fluid. The intraoperative blood loss was around 3000 ml, and urine output was 1600 ml. After surgery, the patient was transferred to the ICU for further treatment.

The tracheal catheter was removed on the second day after surgery, and the patient was transferred back to the thoracic surgery ward for further treatment on the third day.

Discussion

In this case, the patient suffered from shock caused by massive blood loss during the operation. The key to successful treatment was the rapid and extensive replenishment of blood volume [5]. The surgical position and the hemorrhagic shock state severely limited the establishment of venous access. The scope of central venous access was limited, and the traditional venipuncture technique was challenging to perform in a state of circulatory failure [1]. Under real-time ultrasound guidance, punctures of the left great saphenous vein and left forearm median vein were successfully performed using the short-axis plane. The introduction of the ultrasound-guided puncture technique saved valuable time in successfully rescuing and resuscitating the patient during significant blood loss.

Anesthesiologists should be proficient in using ultrasound-guided venipuncture. Ultrasound guidance techniques include single or two-person operations, static or dynamic guidance, and short- and long-axis modes [6]. The key is to accurately identify ultrasound images and master individual puncture techniques rather than adhere to a fixed pattern. In cases of problematic punctures and circulatory failure, it's essential to know the location of peripheral veins and the scanning order, as this directly affects the time required to establish venous access. Studies have shown that, based on anatomical and ultrasonic positioning, the great saphenous vein at the ankle is thicker and shallower than at the calf [7]. Scanning from the ankle to the knee is recommended to choose the appropriate site for vascular puncture and catheter placement [7].

Traditional vascular puncture techniques rely on anatomical positioning and arterial pulsation, which do not effectively evaluate vascular running and lesions through manual palpation to determine vascular elasticity and puncture positioning [1]. Ultrasound visualization enhances the reliability of vascular evaluation results, and real-time guidance facilitates the selection of the optimal puncture point and path. Additionally, ultrasound-guided peripheral venocentesis appears to cause less pain and result in a higher degree of patient comfort compared to conventional techniques [8].

In conclusion, anesthesiologists need to become proficient in ultrasound-guided peripheral venipuncture technology. This technology can help establish venous access in patients with postural restrictions, difficult punctures, and challenging anatomical locations. It is also essential to develop strategies for the emergency rescue of patients with hemorrhagic shock.

Conflict of Interest

The author has read and approved the final version of the manuscript. The author has no conflicts of interest to declare.

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