Technical Report

Use of a modified doppler flow detector for percutaneous cannulation of the internal jugular vein

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To lessen the risks associated with cannulation of the internal jugular vein, a method to identify the contours of the carotid artery and internal jugular vein at the site of cannulation is proposed. This method uses a doppler flow detector equipped with an adjustable electronic filter which selectively enhances the sound component due either to the arterial or venous flow. This method has been applied clinically and was found to be useful in the identification of the vessels. Since doppler flow detectors are readily available in many hospitals and the required modification is simple, we hope that other institutions will find this technique useful in their clinical practice.

In some institutions the internal jugular vein is chosen for the insertion of central venous catheters in preference to the subclavian vein. Pneumothorax, and injury to the subclavian artery or the brachial plexus are associated with the subclavian approach.¹ The internal jugular vein is more accessible to the anaesthetist and offers a straighter

course to the right atrium. However, cannulation of the internal jugular vein is not without hazards. The most commonly reported complication of this technique is haematoma resulted from punctures of the vein or the adjacent carotid artery.²⁻⁴ Occasionally, tracheal intubation or surgical removal of the haematoma is required to alleviate airway obstruction caused by the haematoma.⁵⁻⁷ Although rare, tension pneumothorax associated with attempts to cannulate the internal jugular vein has been reported.⁸

These complications can be avoided if the exact subcutaneous contour of the internal jugular vein and the carotid artery is known. This paper presents a method by which both vessels can be identified prior to internal jugular vein cannulation.

Methods

Ultrasonic flow detector

A commercial ultrasonic doppler flow detector which is readily available was used for this project (Ultrasonic Doppler Flow detector, Model 811, Parks Electronic Laboratory, Beaverton, Oregon). The circuit of the flow detector was modified by interrupting the signal before audio amplification. The signal was diverted through a frequency filter. Selective frequencies were amplified or attenuated as desired by the insertion of an equalizer as described in the Figure. An equalizer marketed for stereos was used for this purpose (Radio Shack Realistic® Model 31-1987). To conform with hospital safety standards, a line isolation transformer was installed in the equalizer.

Key words

ANAESTHETIC TECHNIQUES: CVP catheterization;
COMPLICATIONS: internal jugular vein cannulation;
EQUIPMENT: doppler flow detector.

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FIGURE Schematic circuit diagram of the ultrasonic doppler flow detector (Model 811, Parks Electronic Laboratory) and its modifications. The output from the volume control (VR3) of the doppler flow detector was interrupted at X; where the signal was diverted to the equalizer via coaxial cable A. The equalizer was used as a frequency filter and the signal was returned to the doppler flow detector via coaxial cable B.

Patients

Fourteen patients, who weighed between 50 and 87 kg and were scheduled for cardiac surgery were anaesthetized with a high dose fentanyl/pancuronium technique. The patients were placed in the supine position. Pillows were removed and the patients' heads were rotated slightly to the left. The contour of the right sternocleidomastoid muscle was marked with a surgical marker. After the application of jelly (Aquasonic®) to the neck, the probe of the flow detector was applied on the jelly. With all the settings of the equalizer at 0 db, pistol-shot-like sounds from the flow detector were heard as the detector probe was moved from a medial to a lateral position at the level of cricoid cartilage. This sound pattern was due to the flow in the carotid artery. Closer examination of the sound also revealed a continuous low frequency sound which became louder and then diminished as the probe moved. Because louder higher frequency sound masked the lower frequency sound, the presence and exact position of the latter was not easily recognized.

With the gain of all channels of the equalizer set at the same level, the doppler probe was moved around the triangle formed by the two heads of the sternocleidomastoid muscle. The points of maximum, high pitched, pistol shot-like sounds were

marked with a surgical marker. The points were joined together to form a continuous line. The carotid artery lay directly beneath this line. The equalizer was then altered to attenuate the high frequency component: channels of 60 Hz and 240 Hz at +12 db, channel of 1,000 Hz at 0 db, channel of 3500 Hz at -6 db, and channel of 10,000 Hz at -10 db. The doppler probe was again moved across the right side of the neck. The points of maximum low frequency and continuous sounds were obtained and marked with a surgical marker. The points were joined together to form a line. The right internal jugular vein lay directly beneath this line. Thus we had marked clearly the desired target (the internal jugular vein) and the vessel (the carotid artery) to avoid.

The neck was then sterilized with providone-iodine. A syringe with a 22-gauge needle was used to locate the internal jugular vein. A point as cephalad as possible along the mapped contour and within the area enclosed by the two heads of the sternocleidomastoid muscle was chosen to lessen the risk of pneumothorax. The needle entered the skin in a plane perpendicular to the surface of the neck and directed along the contour of the previously marked line for the internal jugular vein. The tip of the needle pierced the skin at an angle of 30°.

Results

Our patient population included one female patient who had a thick neck, with loose tissue which made it difficult to identify the neck anatomy. A second patient had a large thyroid as well as a thick neck, making it difficult to palpate the carotid pulse. In this patient, the carotid artery contour identified by our method lay more lateral than usual. For all 14 patients studied, venous blood was obtained on the first attempt to enter the internal jugular vein. Therefore, our method identified the location of the internal jugular vein with a success rate of 100 per cent. In each patient, after the identification of the internal jugular vein, a central venous catheter was successfully inserted.

During the course of our investigation, we found that the supine position was optimum to identify the contour of the internal jugular vein. The Trendelenberg position decreased the doppler sound for the venous component significantly. However, once the contour of the vessels was identified, the patients were placed in a Trendelenberg position of

20° to distend the vein and reduce the chance of air embolism. As long as the patient's head remained immobile, this manoeuvre did not alter the position of the internal jugular vein from the marked position.

Discussion

The doppler flow detector is a valuable tool to detect arterial flow for measurement of blood pressure.^{9,10} Theoretically, it should be useful in locating blood vessels for cannulation. Less enthusiasm has been displayed in this latter application, presumably because manual palpation and blind cannulation have been the tradition. Nonetheless, a doppler detector has been used to localize the infraclavicular subclavian vein for percutaneous catheterization.¹¹ Similarly, a doppler flow detector with a modified probe has been used to aid in the percutaneous cannulation of the radial artery in infants and small children.¹²

We have presented a method to identify the right internal jugular vein by use of a modified doppler flow detector. The method has been applied successfully in a small series of patients. We confined our study to the right side of the neck and have no information on its applicability on the left, which is anatomically more complicated. We have not encountered any complications with our method, but this could be due to the small sample size in our study. To compare the risk of complications associated with our method with that of existing methods requires a more extensive study. Nevertheless, our method offers an alternate to the conventional methods of blind cannulation. Since the doppler flow detector is readily available in many hospitals and the modification is simple, we hope others will employ this method and find it useful in their clinical practice.

Acknowledgements

The authors thank Dr. S.J. Teasdale, Department of Anaesthesia, Toronto General Hospital, and Dr. R.E. Creighton, Department of Anaesthesia, The Hospital for Sick Children, and the University of Toronto for their interest and support of this project.

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Résumé

Afin de diminuer les risques associés à la canulation de la veine jugulaire interne, une méthode qui identifierait les contours de l'artère carotide et de la veine jugulaire interne au site de la canulation est proposée. Cette méthode utilise un détecteur de flot doppler équipé avec un filtre électronique réglable qui augmentera sélectivement les composantes du bruit provenant soit du flot artériel ou veineux. Cette méthode a été appliquée en clinique et jugée utile pour identifier les vaisseaux. Etant donné que les détecteurs de flot doppler sont disponibles dans plusieurs hôpitaux et que les modifications requises sont simples, on espère que d'autres institutions trouveront cette technique utile dans leur pratique.