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A comparison of external and internal jugular venous pressures to monitor pulmonary artery pressure after superior cavopulmonary anastomosis

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Abstract

The internal jugular vein continues to be the preferred site for cannulation to monitor central venous pressure despite the reported evidence of the accuracy of external jugular venous pressure (EJVP) to reliably predict internal jugular venous pressure (IJVP). Internal jugular venous cannulation carries a risk of thrombosis that can be life-threatening in children undergoing superior cavopulmonary anastomosis and a subsequent Fontan procedure. The present study compared IJVP and EJVP in children undergoing superior cavopulmonary anastomosis and found no statistical and clinical difference between IJVP and EJVP. Thus, external jugular vein cannulation reliably predicts IJVP and pulmonary artery pressures in children undergoing superior cavopulmonary anastomosis, and may obviate the risk of life-threatening cavopulmonary thrombosis.

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1. Introduction

The success of superior cavopulmonary anastomosis (bilateral Glenn shunt) and subsequent Fontan procedure [1] depends on the patency of the systemic venous circulation, which is the driving pressure for flow across the pulmonary artery. At the same time, the perioperative management of patients undergoing superior cavopulmonary anastomosis requires monitoring of pulmonary artery pressure (PAP), which is usually performed through a small cannula inserted into the right internal jugular vein. This cannula itself is a risk factor for life-threatening venous thrombosis, more so in patients with elevated superior vena caval pressures—a situation commonly found after superior cavopulmonary anastomosis [2].

External jugular venous pressure (EJVP) has been suggested to be an acceptable estimate of central venous pressure/internal jugular venous pressure (IJVP) in the supine position [3, 4], the position commonly used for superior cavopulmonary anastomosis and Fontan procedure. Moreover, the risk of thrombosis of the internal jugular vein is obviated with external jugular vein cannulation.

This study evaluated the EJVP in comparison to the IJVP as a reliable estimate of PAP in children undergoing superior cavopulmonary anastomosis on cardiopulmonary bypass (CPB).

2. Methods

Thirty children in the age group one to three years undergoing superior cavopulmonary anastomosis on CPB were included in this prospective study after institutional Ethical Committee approval and parental consent.

After induction of anesthesia and tracheal intubation, two 20 G venous cannulae (Becton Dickinson India Ltd, Bhiwadi, India) were inserted, one in the right internal jugular vein and the second in the right external jugular vein, with an aseptic technique. Both the cannulae were connected to pressure transducers (Truwave disposable pressure transducer; Edwards Lifesciences LLC, Irvine, CA, USA), and the mean pressure at the two sites was monitored. The neck position was neutral, and the patient was kept in supine position. The external jugular vein cannula was positioned such a way as to achieve free aspiration of blood. This was done to ensure that the cannula tip did not abut a valve in external jugular vein and would show an accurate pressure measurement.

The mean pressure in the right internal and right external jugular veins was recorded at the following predefined time points: (1) pre-sternotomy, (2) post-sternotomy, (3) at the time of superior vena cava clamping, and (4) after completion of the superior cavopulmonary anastomosis.

In all children, the superior cavopulmonary anastomosis was carried out on CPB without aortic cross-clamping at normothermic temperature. The cannulae in the right internal and right external jugular veins were removed within 24 h of procedure as per institutional protocol.
Statistical comparison between mean pressures recorded from the right internal and right external jugular veins at predefined time points was carried out using an unpaired t-test.

3. Results

External and internal jugular vein cannulation were both carried out on the right side in all the patients. Free aspiration of blood was possible from both cannulae in all patients.

The age of patients included in the study varied between 12 and 36 months, with a mean of 18.3 months. The mean weight of the patients was 12.37 kg, with a range of 7–20 kg. The external and internal jugular vein pressures were analyzed using an unpaired t-test at all the predefined time points. A P-value < 0.05 was considered significant.

The difference between the two pressures at all time points was neither clinically nor statistically significant (Table 1). A difference between the IJVP waveform and the EJVP waveform was noted in terms of a better delination of waveform components (a, c and v waves) in the IJVP compared to the EJVP waveform at time points 1 and 2, but there was no difference between the two waveforms after superior cavopulmonary anastomosis.

4. Discussion

The Fontan circulation depends upon the venous pressure as the driving pressure for blood flow across the pulmonary artery as the ventricle is excluded from the right side of the circulation. The use of an internal jugular vein cannula to monitor PAP in children undergoing superior cavopulmonary anastomosis is an accepted modality [5] but carries a small but definite risk of thrombosis. A thrombus in the internal jugular vein will not only interfere with cerebral venous drainage and thus increase intracranial pressure (ICP), but may also cause early failure of the Fontan circulation.

Life-threatening cavopulmonary thrombosis in patients undergoing superior cavopulmonary anastomosis has been reported by Forbes et al. [2]. These authors identified elevated superior vena cava pressure as one of the risk factors for internal jugular vein thrombosis in patients undergoing superior cavopulmonary anastomosis – a situation commonly found in the postoperative period. An internal jugular vein cannula in this situation will act as a nidus for thrombus formation [6].

The present study compared the EJVP to the IJVP as the EJVP has previously been shown to be a reliable estimate of UVP [3, 4]. Leonard et al. [7] reported a comparison of the EJVP and IJVP during repair of a proximal femoral fracture. They reported a good agreement between the IJVP and EJVP in the supine position (limits of agreement −2.6 to +1.9 mmHg). However, the agreement became poor in the lateral position.

Although the risk of thrombosis is present even with an external jugular vein cannula [8], a thrombus in the external jugular vein may be limited in extent due to the presence of valves in this vein. Moreover, the intracranial pressure will not rise and the Fontan circulation will not fail even if there is a thrombus in the external jugular vein. The statistical and clinical similarity between the EJVP and IJVP in the present study highlights the importance and accuracy of EJVP as an estimate of PAP in children undergoing superior cavopulmonary anastomosis.

Internal jugular vein cannulation has become standard practice in cardiac surgery for monitoring central venous pressure. The advantages of the internal over the external jugular vein include the absence of valves, a straighter course to the superior vena cava, and less torsion and kinking with changes in neck position [9]. In the present study, particular care was taken to have free aspiration of blood from the external jugular vein cannula, maintenance of a neutral neck position, and careful monitoring of the EJVP and IJVP waveforms to obviate the problems associated with EJVP monitoring. Both waveforms (IJVP and EJVP) were similar in all patients after superior cavopulmonary anastomosis, which suggests a true reflection of PAP.

Neurocognitive dysfunction after superior cavopulmonary anastomosis [10, 11] is usually due to raised superior vena cava pressure, which impairs cerebral venous drainage and thus increases ICP. The presence of a thrombus in the internal jugular vein will increase the risk of a raised ICP and thus the incidence of neurocognitive dysfunction. Although it can be avoided with external jugular vein cannulation, scientific evidence to this effect is lacking and requires a controlled study.

The limitations of the study include a low sample size and a lack of randomization. However, we have 30 sets of control and test values that give us a fairly reliable comparison of the EJVP and IJVP. A comparison of the incidence of external vs. internal jugular vein thrombosis was not made in our study.

Thus, EJVP monitoring in children undergoing superior cavopulmonary anastomosis provides a reliable estimate of PAP and may obviate the risk for life-threatening thrombosis.

References


**eComment: Advantage and judicial use of internal jugular vein**

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As mentioned by the authors [1], the internal jugular vein is commonly used for the Glenn procedure because of better alignment with the right atrium and lack of uni-directional valve. The use of the external jugular vein has some practical problems such as cannula tip touching on the valve, possible false reading, and chance of thrombosis being greater with superficial vein than with deep vein. The line placed into the internal jugular vein for a Glenn procedure normally comes out within 24 h and if Glenn flow and pulmonary artery pressure is adequate, the chance of thrombosis is negligible. In their Discussion, the authors mention that thrombus in the internal jugular vein causes early failure of the Fontan circulation. This statement demands discussion as it is true only when there are coagulation disorders.

In this study, coagulation disorders which are commonly seen in cyanotic children, are not taken into consideration. In my experience if the IJV is used for a short duration, it is a better option for measuring correct superior vena cava/Glenn pressure.

**Reference**