Inadvertent Carotid Artery Cannulation with Malposition of Catheter Tip in Right Ventricle in Tetralogy of Fallot Patient Undergoing Total Intracardiac Repair – A Case Report

Abstract
Central venous catheterization is an essential procedure in patient undergoing cardiac surgery, as it provides central venous pressure monitoring, fluid administration, and infusion of inotropes during perioperative period. In the cardiac surgery, where the patients are anticoagulated, an inadvertent arterial puncture can lead to serious complications. Hematoma following inadvertent arterial puncture is one of the common complications, which can compromise cerebral circulation. We report a rare case of inadvertent cannulation of internal carotid artery in patients of tetralogy of Fallot undergoing intracardiac repair during an attempt to cannulate internal jugular vein.

Keywords: Carotid artery cannulation, central venous cannulation, tetralogy of Fallot

Introduction
A central venous catheterization provides rapid, reliable vascular access for pediatric heart surgery. Internal jugular vein (IJV) is preferred by many practitioners because it has a short, straight course to the superior vena cava, and fatal complications such as pneumothorax or hemothorax are rare. In cyanotic congenital heart disease patients, carotid cannulation can be misinterpreted as venous cannulation because of high hematocrit and dark-color blood. We report a rare case of inadvertent cannulation of internal carotid artery in patients of tetralogy of Fallot undergoing intracardiac repair and the steps taken to treat following its recognition. The malpositioned central venous catheter tip has been noticed by surgeon during cardiopulmonary bypass (CPB) when right atrium was opened.

Case Report
A 7-year-old male child, weighing 22 kg, presented with bluish discoloration of skin since childhood. On admission, his temperature was 36.4°C, respiratory rate was 20/min, pulse rate was 74 beats/min, blood pressure was 94/58 mm Hg, and oxygen saturation level was 84% (room air). Baseline coagulation parameters were within normal limits and hematocrit was 51%. Transthoracic echocardiography revealed large 12-mm perimembranous ventricular septal defects (VSD), severe infundibular stenosis with peak gradient of 74 mm Hg, and 50% aortic override and right ventricular hypertrophy. Surgery was planned for intracardiac repair under CPB.

Inside the operating room, electrocardiography, pulse oximetry, and noninvasive blood pressure were applied. Anesthesia was induced with inhalational sevoflurane; simultaneously, peripheral venous line was secured in right upper limb with 22 G cannula followed by fentanyl 5 μg/kg/body weight, and intubation was done with 5.5-mm cuffed endotracheal tube facilitated by vecuronium 0.1 mg/kg and kept on pressure control mode of ventilation with an oxygen–air mixture of 50:50%. A 22-ga arterial catheter was inserted in left radial artery.

Certofix trio, 7 Fr, triple-lumen central venous pressure (CVP) catheter was used for catheterization. The patient was placed in a 15° Trendelenburg position with head turned slightly toward the left side and stabilized with folded sheet. Right side of the neck region was cleaned with an antiseptic solution. Due to unavailability

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of ultrasound, machine conventional blind technique of central venous cannulation was used. A 22-ga finder needle attached with a 2-ml syringe was inserted at the apex of the triangle formed by the two heads of the sternocleidomastoid muscle, directed toward the ipsilateral nipple at an angle 30–40° with the skin. Return of dark and sluggish flowing blood to the syringe attached to the needle confirms entry into the IJV. Once the vein was located, catheterization proceeded in the same track with introducer needle as the “finder” needle using the Seldinger technique with an 18-ga thin-walled needle. Confirmation of position of the CVP catheter was performed by connecting the catheter to the transducer. Following transducing, measured pressure was 98/10 mm Hg [Figure 1]. In Tetralogy of Fallot physiology, the right ventricular and left ventricular systolic pressure becomes equal. Considering high systolic pressure and low diastolic pressure as right ventricular pressure, catheter was withdrawn 2 cm. However, even after 2 cm withdrawal, measured pressure was the same. Hence, it was secured at 11 cm with sutures and surgeon was asked to cut tip of the catheter.

Anesthesia was maintained by isoflurane, fentanyl infusion 1 µg/kg/h, and vecuronium boluses. A standard anticoagulation technique was used for all the patients before cannulation. Heparin 4 mg/kg was given for achieving activated clotting time (ACT) more than 480 s. During bypass, ACT was obtained every hour, to determine adequacy of anticoagulation. After achieving ACT of more than 480 s, aortic and venous cannulation was performed. Heart arrested with del nido cardioplegia. On opening right atria, through tricuspid valve, central venous catheter tip was visualized in right ventricle. On tracing the pathway of catheter, it was coming from aorta to VSD to right ventricle. In view of bleeding risk, central line catheter was kept in situ and 3 cm length of central line tip was cut in view of surgical obstruction during VSD patch closure. Surgical procedure consisted of Polytetrafluoroethylene patch closure of VSD and resection of Right ventricular outflow tract obstruction under CPB support. Left-sided IJV catheterization was performed after removing aortic cross-clamp on partial CPB. Patient was shifted to surgical intensive care unit on infusion of noradrenaline 0.05 µg/kg/min. After shifting patient to ICU, chest X-ray was performed and it revealed right-sided catheter in aorta and left-sided catheter in IJV. Right-sided central venous catheter was removed 2 h after shifting patient to surgical intensive care unit and catheterization site was pressed with gauge for 20 min; no hematoma formation was noticed. Patient was extubated after 16 h and discharged from hospital on postoperative day 7.

Discussion

IJV catheterization is an essential procedure for patients undergoing open-heart surgery, which is relatively easy to cannulate, and fatal complications such as pneumothorax or hemothorax are rare. Malposition of central venous catheters has been reported at a rate ranging from 1% to 33%. Complications that can occur are internal carotid artery puncture, pneumothorax, thrombosis, malposition of the catheter, and infection, with the most common being internal carotid artery puncture, because of the proximity of the artery and vein. Early identification and management of complications associated with central line placement are an important component of safe anesthesia practice.

In cyanotic congenital heart disease patients, carotid cannulation can be misinterpreted as venous cannulation because of high hematocrit and dark-color blood. In our case, right internal carotid artery was cannulated instead of IJV because of abovementioned cause. Confirmation of position of the CVP catheter was performed by connecting the catheter to the transducer. Measured pressure was 98/10 mm Hg. Considering high pressure as right ventricular pressure, catheter was withdrawn 2 cm and secured at 11 cm with sutures, and a sterile dressing was done. In tetralogy of Fallot, due to right ventricle outflow tract obstruction and large perimembranous VSD, over the time, right and left ventricular pressure becomes equal. Moreover, there is 50% aortic override, which means 50% of aorta is originating from right ventricle and 50% from left ventricle. During an attempt to central venous catheterization, CVP tip went to right ventricle from aorta, giving impression of catheter tip in right ventricle through tricuspid valve. Thus, techniques such as blood backflow and blood color comparison should be cautiously used in cyanotic congenital heart disease.

Mainly two techniques are commonly used for the management of carotid artery cannulation with a large bore catheter. These techniques are either removal of the catheter and application of direct pressure or surgical exploration, repair. Guilbert et al. reported serious complications in up to 47% of patients treated by removal of the catheter and application of direct pressure, which included death in several cases. No complications from
surgery or catheter misplacement were reported in those patients treated via surgical repair in the same study.

The best technique is to perform central venous cannulation under the guidance of real-time ultrasonography. Ultrasonography allows cannulating physician to differentiate between artery and vein through its ability to display arterial pulsatility and venous compressibility. Real-time ultrasound usage decreases thrombotic, infectious, and mechanical complications associated with central venous cannulation.[7] Moreover, visualization of guidewire by transthoracic echocardiography through superior vena cava before dilation prevents this catastrophic complication.

Limited availability of ultrasound and transthoracic echocardiography, especially in the developing nations, mandates the use of blind technique using anatomical reference points for central venous cannulation.

In conclusion, central venous cannulation should be performed under the guidance of ultrasound, especially in cyanotic congenital heart disease where blood backflow and blood color comparison may not give conclusive evidence. Utilization of ultrasound and transthoracic echocardiography for central venous cannulation in operation theater ensures quality improvement.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Conflicts of interest

There are no conflicts of interest.

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