ORIGINAL ARTICLE

Percutaneous Central Venous Catheterisation in Critically Ill Children

A Y T Goh, MRCP*, L C S Lum, MRCP*, P W K Chan, MRCP*, M Roziah, MBBS**, *Paediatric Intensive Care Unit, Department of Paediatrics, **Department of Radiology, University Malaya Medical Centre, 50603 Kuala Lumpur

Summary

An 18-month analysis of 52 percutaneously placed central venous catheters in 48 critically ill children was done. Success rate were 91.7% (33/36) and 93.8% (15/16) for femoral and non-femoral catheters respectively. Presence of hypotension (48.1%) and significant coagulopathy (26.9%) did not affect the success rate significantly. Minor bleeding and venous congestion was seen in 5.5% (2/36) of patients with femoral catheters. Infections were found in 2.7% (1/36) of femoral and 6.6% (1/15) of non-femoral catheters. The low incidence of complications and the relative ease of insertion makes the femoral route the preferred site for trainee medical officers in critically ill children when central access is indicated.

Key Words: Venous access, Central venous catheters, Femoral vein

Introduction

Vascular access in critically ill children is of paramount importance both for monitoring as well as therapeutic purposes. Peripheral venous access can be difficult in children when compared to adults [1] thus catheterisation of central veins may be needed to provide access. Previous reports have advocated the use of the subclavian or internal jugular route [2,3,4]. These routes however can be associated with life-threatening complications [5,6]. More recently reports have shown the efficacy and safety of the femoral route for central venous cannulation [7,8,9]. The use of invasive central venous catheterisation in developing countries like Malaysia with its limited resources and expertise has not been well studied. Skills in central venous catheterisation are routinely taught to medical officers in surgery, medicine and anaesthesia but not to paediatrics. The present study reports on an observational surveillance of routine central venous catheterisation in a paediatric intensive care unit in Kuala Lumpur by trainee paediatric medical officers and specialists.

Materials and Methods

Patient population. From May 1996 to October 1997, 52 central venous catheters were placed in 48 patients admitted into the Paediatric Intensive Care Unit (PICU), University Malaya Medical Centre. It is a multidisciplinary unit that admits patients from the newborn period up to 12 years old. There are 2 paediatric specialists and 2 resident medical officers who generally perform all procedures during the office-hours whereas medical officers from the general pool perform procedures after hours. Only catheters placed in the PICU was included. Patients undergoing routine cardiac catheterisation were excluded.

Insertion site selection. The insertion site selection was the prerogative of the attending physician. Medical officers generally preferred femoral venous catheters unless contraindicated (Table I for relative contraindications). Specialists chose either subclavian or femoral based on their experience. Positive pressure ventilation and age were not factors in site selection decisions.

Table I

Relative Contraindications for Femoral Vein Catheterisation (9)

Abdominal mass compressing vena cava
Trauma involving lower extremity, pelvis or inferior vena cava
Local skin or soft tissue lesion
Malformation of lower limb causing potential vascular disruption
Femoral hernia
Planned for future transfemoral cardiac catheterisation

Catheter selection and placement techniques. Polyethylene catheters were used throughout the study period. Femoral catheter tips were placed above the diaphragm in the right atrium and subclavian catheters in the superior vena cava-right atrial junction. Positions were assessed radiographically. Catheters were placed using the Seldinger technique with local anaesthetic after preparation of skin by povidine-iodine solution. A semipermeable, adhesive plastic dressing was applied with care to prevent perineal contamination. Insertion techniques, site preparation and care were identified for femoral and non-femoral catheters. Medical officers (both PICU residents and on-call MO's) were allowed to insert femoral catheters under direct supervision of PICU specialists, and later on on their own after demonstrating proficiency in the technique. As non-femoral catheters were potentially associated with more serious complications they were generally inserted by PICU specialists or senior medical officers.

Data collection. Prospective collection of epidemiological data, admission Paediatric Risk of Mortality (PRISM) score, site of catheter insertion, the use of treatment modalities, haemodynamic status, presence of significant coagulopathy and complications were done. Hypotension was defined as a systolic blood pressure less than the 3rd centile for age. Coagulopathy was defined as a PT ratio of > 1.4 with or without thrombocytopaenia (platelet count < 50,000/ul). Complications were noted by the attending staff and the PICU nurses daily. All patients developing fever with an indwelling catheter was suspected to have a line infection. Isolation of the same organism of the same species with similar antibiotic sensitivities from a paired peripheral and catheter blood culture in the absence of another demonstrable source of infection confirmed a catheter infection. Treatment of choice was by removal of the catheter.

Statistical analysis. A chi squared analysis was done to compare differences.

Results

Fifty-two central venous catheterisations were attempted in forty-eight patients. During the study period 8102 patients were admitted to the Paediatric Department. Thus 0.64% of paediatric or 10.5% (52/495) of PICU admissions required a central venous catheter. The median age was 19 months (range 1-144 months) and the patients were mainly very ill, with a mean PRISM score of 25.34 ±1.54 SEM. Hypotension was present in 48.1% (25/52) and significant coagulopathy in another 26.9% (14/52). Fifty percent of the patients were less than 18 months old. Thirty-six femoral venous catheterisations were attempted with a success rate of 91.7% (33/36). Twenty-five were right sided and 8 were on the left side. Medical officers were able to insert 86.1% (31/36) of the femoral catheters attempted. Of the 3 failures subsequent attempts by specialists also failed. In total, medical officers inserted 93.9% (31/33) of all femoral catheters. Success rates of femoral catheterisations were not influenced by presence of hypotension (83% vs. 100%, p = 0.22) or coagulopathy (92% vs. 93%, p = 0.7). Sixteen non-femoral catheters were attempted (11 subclavian and 5 internal jugular) with a success rate of 93.8% (15/16). The median duration of catheterisation was 4.5 days (range 1-19 days). The duration was ≤ 5 days in 50% and ≤ 7 days in 75% of patients. Only two patients had catheterisation ≥14 days. Characteristics of patients and complications from femoral and non-femoral catheters are shown in Table II. Two patients developed venous

congestion with mild leg swelling which improved within 48 hours of catheter removal. The 2 patients with indwelling catheters ≥ 14 days (1 femoral and 1 subclavian catheter) developed catheter related infections with *Staphylococcus epidermidis* and *Staphylococcus aureus* giving an infection rate of 2.7% and 6.6% respectively.

Discussion

Central venous catheters are needed for haemodynamic monitoring in a proportion of critically ill children. Catheter site selection depends on the route in which this access can be achieved rapidly with the minimal short and long-term side effects. The femoral site has several distinct advantages in that the femoral anatomy is easily learned and the arterial pulse forms a definitive landmark. Hypotension with accompanying reduction of the femoral pulse did not significantly affect the success rate. In addition the femoral route also avoids the serious complications associated with subclavian and internal jugular catheterisation, namely thoracic duct laceration and pneumothorax. This practical advantage can however be undermined by the theoretical increase in infection rate from skin and perineal contamination. We have however shown that the use of proper semipermeable dressing coupled with stringent nursing care of the perineum together with continuos bladder drainage or diapers gives a comparably low infection rate when compared to the non-femoral route. Gram negative infection from enteric contamination was not seen. Vascular complications from femoral insertion were often associated with inadvertent puncture of the femoral artery. The developing haematoma and bleeding were easily controlled with local pressure.

Table II

Differences in Characteristics Between Femoral and Non-Femoral Catheterised Patients

Variable	Femoral	Non-Femoral	p-value
No	36	16	-
Mean age (months)	29.4 ± 34.4	50.8 ± 49.6	0.08
M : F sex ratio	1.6 : 1	1:3 : 1	0.76
Clinical characteristics			
Hypotension, No (%)	18 (50)	7 (44)	0.76
Coagulopathy, No (%)	11 (31)	3 (19)	0.50
Mortality, No (%)	15 (42)	11 (68)	0.13
Catheter insertion			
Expertise-inserted by MO's, No (%)	32 (89)	5 (31)	0.00006
Mean duration, days	5.0 ± 4.7	5.1 ± 3.4	0.96
Bleeding, No (%)	2 (6)	2 (12)	0.78
Infection, No (%)	1 (3)	1 (6)	0.93

Venous obstruction and congestion often resulted from the relatively large size of the catheters in contrast to the vessel diameter. This often occurred in infants, who have a relatively small vessel caliber. No long-term problems were seen after removal of these catheters.

Paediatric medical officers with initially limited experience were able to insert femoral venous catheters with a high degree of success. With improvement in the learning curve they soon became proficient in this technique. They were often inserted in critically ill children who were hypotensive and undergoing fluid resuscitation together with other simultaneous procedures. The relative ease of insertion and low complications make the femoral route the site of choice for training medical officers in critically ill children. Skilled intensivists may however prefer other routes based on individual preference. Pressure waveforms are less dumped in the non-femoral route due to the relatively shorter length of catheter tubing and may be the site of choice. Site selection guidelines will have to take into account operator skill and expertise.

The rate of central venous catheterisation in our paediatric population was lower than those in North America, which is about 25% of PICU admissions and 1.8% of hospital admission [8]. The cautious use of this invasive technology should be lauded in light of recent data from other developing countries, which showed and increase morbidity and mortality in low risk patients who were subjected to invasive procedures [10]. Fear of subsequent undetected deterioration and convenience should not be the main indication for catheter insertion.

Conclusion

Percutaneous femoral venous catheterisation can be carried out in infants and children with a high degree of success. Medical officers were able to acquire the skill and accomplish the task with relative ease and with acceptably low complication rates. It should be the route of choice for training medical officers when central access is indicated. The skill of femoral catheterisation is an acceptable educational goal for all paediatric training medical officers.

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