**Title: Open vs Ultrasound guided tunnelled central venous access in children- A randomised controlled trial**

Investigators

Soundappan SVS

Karpelowsky J

Thomas G

Lawrence L

Cass DT

**Introduction**

Tunnelled Hickman’s catheters and implantable venous access devices are used for administration of chemotherapy, total parenteral nutrition or replacement of factors. These are often inserted by open surgical technique. A recent study demonstrated safety of percutaneous access in children with minimal complications [[1](#_ENREF_1)]. While ultrasound guided percutaneous access has been compared and proven to be safer than blind punctures [[2](#_ENREF_2)] it has not been compared with open surgical access.

**Literature review**

Central venous lines are need in children for a variety of indications such as parenteral nutrition, chemotherapy, replacement of factors, antibiotic therapy etc. These children often have associated co-morbidity and are often sick increasing the risk of line related complications such as infection and thrombosis. Central lines can be inserted directly into one of the large central veins or through a peripheral vein in to the central vein. They can be tunnelled or non- tunnelled single or multiple lumen catheters and with or without a cuff.

Traditionally tunnelled cuffed catheters were inserted by surgical open cutdown. Recently ultrasound guided percutaneous access is being used increasingly in some centres and is recommended as the procedure of choice for central venous access. Ultrasound guided insertion of central lines has proven to be safe and minimise complications associated with blind needle puncture [[3](#_ENREF_3)]. Ultrasound guidance reduces puncture related complications such as arterial punctures. Adult and paediatric literature site upto 35% failure to cannulate with landmark technique [[4](#_ENREF_4)] [[5](#_ENREF_5)] [[6](#_ENREF_6)]. 99% success at venous cannulation has been demonstrated in paediatric and adult series [1] [5]. Ultrasound guided puncture has been accepted as standard of practice for adults. UK centre for excellence recommends ultrasound guided percutaneous access as standard care for temporary line insertions. A large study from Birmingham proved safety of this technique in children of all ages when performed by Paediatric surgeons and anaesthetists [1].

Infection and thrombosis are potential problems that can occur due to contamination at the time of insertion or inappropriate care of lines during treatment[7]. Thrombosis and vein occlusion are higher with open technique presumably from handling of the vessels and sutures used to achieve haemostasis from venotomy (1). Multiple needle passes, arterial puncture, pneumothorax, bleeding and haematoma are potential complications of landmark technique [1]. Davis et al [8] compared open insertion with percutaneous insertion based on anatomic landmark in adults and proved it was safer and quicker; however, the complication rate in their study between the two groups was similar (18% open vs16% perc). Basford et al [9] compared late complications in open vs percutaneous techniques and found infectious (47% vs 16%) and mechanical (50 vs 16%) complications were higher in the open group. Non-elective removal of surgically inserted tunnelled lines and ports was also higher. Ours will be the first randomised trial comparing open vs. ultrasound guided percutaneous catheter insertion in the paediatric age group.

**Aim**

To demonstrate percutaneous ultrasound guided insertion of tunnelled central venous lines is superior to open insertion of line in terms of reduction of complications and operating time.

**Hypothesis**

1**.** Complications will be reduced by 50% compared to the open technique.

2. It is hypothesised that ultrasound guided will be quicker than open cut down technique with atleast 25% reduction in operating time

3. Conversion rate to open insertion will be less than 5 %

**Methods**

**Trial design**: single blinded randomised controlled trial

**Participants**: Eligibility criteria – All children >0 to < 16 referred for insertion of Hickman’s or Implantable vascular access device for total parenteral nutrition, chemotherapy or replacement therapy will be included in the study. The study will be performed at The Children’s Hospital at Westmead. Ultrasound guided access will be the study group compared to the control group of open cut down insertion.

**Exclusion-** 1.Patients with loss of both internal jugular veins from prior catheter insertion will be excluded.

2. Children with vascular access into veins other than internal jugular vein.

3. Patients having central line as an for trauma or other emergency indications

**Recruitment of subjects**

Patients referred for surgical line insertion are seen by the surgeon or surgical registrar. Patients meeting inclusion criteria will then be offered participation in the study. Consent will be obtained. Randomisation will occur by computer generated number in a 1:1 ratio between treatments. Allocation will be done by a Surgical fellow who is not participating in the study.

Sample size is calculated on the basis of the primary outcome namely reduction in complications. A sample size of 150 patients per treatment arm will allow a difference in complication rate of 30% versus 15% to be detected with 80% power at 5% significance and allows for loss to follow up and/or non-compliance due to conversion from percutaneous to open technique up to a total of 10%. A data monitoring board will review data 6monthly for complications..

**Interventions:**

All procedures are performed under general anaesthesia. Radiographer should be present at start of procedure for both techniques to avoid undue delay and thus increased operating time.

Percutaneous access

Procedure is performed under general anaesthesia. Patient is positioned supine with a roll under shoulders to extend neck. Right internal jugular vein will be preferred site unless it has already been used. Ultrasound measurement of internal jugular vein to carotid artery will be performed just above the clavicle and site of puncture selected. Initial needle puncture will be performed under ultrasound guidance. 4.2, 7 or 9 Fr Bard percutaneous access kits will be used for insertion of double lumen catheters depending on age and weight of the child and indication. Vortex kits will be used for insertion IVADs.

In children younger than 10kgs a cook conversion kit will be used to gain access to vein. Cook 3fr conversion kit dilator and sheath will be inserted over guidewire and 0.025 or guidewire will be introduced next. Exit site over anterior chest wall is chosen and catheter tunnelled through. The catheter will be tunnelled from pectoral region to the needle puncture site. Dilator and peel away sheath will be introduced over the guidewire and position confirmed under image intensifier and catheter will be cut to appropriate length at the same time to site tip of catheter at level of junction of SVC and right atrium. Catheter will be introduced as sheath is peeled away. Position and function of catheter will be confirmed before suture closure of neck and purse string suture around exit site over chest wall.

Open access:

Patient positioned supine with roll under shoulder. Neck turned away from side of insertion of line. Internal jugular vein is accessed through low neck incision along skin crease over lower sternomastoid. The internal jugular vein is exposed through the triangle between the two heads of the sternomastoid and looped. Exit site over chest wall is chosen and catheter is tunnelled through. Catheter is cut to length at level of sternal angle to position it at level of SVC right atrial junction. Venotomy is made and catheter is inserted. Position of catheter is confirmed with image intensifier. 6-0 prolene suture is applied to achieve haemostasis at venotomy site. Catheter function is checked and wounds closed with vicryl sutures.

Neck wounds will be dressed with opaque occlusive dressing and catheter exit site or port site will be dressed with standard occlusive dressing.

Vessel dimensions will be recorded just above the clavicle at the time of line removal either at completion of therapy or due to complications.

Cases will be reviewed by an independent observer for immediate complications. Patients will be followed up until line removal at end of treatment or 2 years whichever is earlier.

**Outcomes**

**Primary**:

1. Incidence of infectious or mechanical complication

Infection

Exit site infection

Tunnel infection

Catheter associated bacteraemia

Mechanical Complications

Malposition of catheter

Occlusion of line

Breakage of line

Thrombosis of vein

Narrowing of vein

**Secondary**

1. Time taken to complete procedure (Broviac and port insertion times will be analysed as separate groups)

-Start time is time of incision with open surgery and time of needle puncture with percutaneous procedure.

-End time is time at completion of dressing

1. Complications at insertion

Number of passes

Bleeding

Haematoma

Arterial puncture

Haemo or pneumothorax

Conversion

3. Non-elective removal of line

4. Total duration of line use in days

**Definitions**

***Bleeding***- Haemorrhage significant enough to require surgical intervention or blood transfusion

***Haematoma****-* Collection of blood in the subcutaneous and deeper planes causing bruising and discolouration of overlying skin.

***Arterial puncture***-Needle puncture of carotid artery during percutaneous access

***Haemothorax***- Collection of blood in the pleural cavity

***Pneumothorax***- Collection of air in the pleural cavity

***Malposition of catheter***- Acceptable position of catheter tip is from junction of superior venacava and atrium to midatrial level. Any position proximal or distal to this level will be considered malpositioned.

***Occlusion of line***- Resistance to flow through catheter or inability to flush due to clotting or precipitation within lumen or formation of fibrin sheath

***Breakage of line*-** Leaking of fluid or blood onto dressing or skin.

***Thrombosis of vein*-** Formation of clot in the vein causing pain, shoulder or facial oedema and difficulty aspirating or flushing catheter.

***Narrowing of vein*-** Decrease in diameter of vein at insertion site as seen on imaging

***Infection****-* *Exit site or tunnel infection* as evidenced by pain, swelling, redness over the tunnel or around exit site associated with discharge of pus.

***Catheter related blood stream infection***

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| **NSW Health definition of central line associated blood stream infection for adults and paediatrics38** | |
| The bloodstream event must meet one of the following three criteria (criteria 1 and 2 may be used for patients of any age, including patients < 1 year of age): | |
| **Criterion 1:**  Patient has a recognised pathogen cultured from one or more blood cultures and organism cultured from blood is not related to an infection at another site. | ) |
| **Criterion 2:**  Patient has at least one of the following signs or symptoms:  ■ fever (>38ºC); ■ chills; ■ or hypotension; and displays:  ■ signs and symptoms of infection and positive laboratory results are not related to an infection at another site and common skin contaminant is cultured from two or more blood cultures drawn on separate occasions.  **Criterion 3:**  Patient < 1 year of age has at least one of the following signs or symptoms:  ■ fever (>38ºC, rectal);  ■ hypothermia (<37ºC, rectal);  ■ apnea;  ■ or bradycardia and displays:  ■ signs and symptoms of infection and positive laboratory results are not related to an infection at another site and common skin contaminant is cultured from two or more blood cultures drawn on separate occasions. | |

**Statistical methods**

Basic descriptive statistics will be used to describe all outcomes in each treatment group and overall, and treatment effects will be presented as odds ratios or differences in means with associated 95% confidence intervals. All analyses will be performed according to the intention-to-treat principle using a two-sided significance level of 0.05. Categorical outcomes will be compared between treatments using chi-square tests, continuous outcomes will be compared between treatments using t-test or non-parametric methods. Linear or logistic regression analysis will be employed to explore the impact of other prognostic variables on the association between randomised treatment and outcomes

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**Data collection**

Data will be entered into a password protected computer. Access to data will be restricted to principal researcher only. Data will be stored for 15 years and then erased.

**References**

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