SCIENTIFIC LETTER

Use of 3 French catheters for diagnostic and interventional procedures in newborns and small infants

G Agnoletti, Y Boudjemline, E Largen, Y Aggoun, I Szezepanski, D Bonnet, D Sidi

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As a result of advances in cardiac surgery and interventional treatment, cardiac catheterisation is now being performed more often in neonates and small infants. In these patients the vascular approach is a major concern because of limited vascular access and the potential for vascular damage.^{1,2} For these reasons, the miniaturisation of diagnostic catheters and interventional tools to preserve vascular access in small patients is of vital importance.

The aim of our study was to assess the feasibility and safety of diagnostic and interventional procedures performed in small infants using 3 French sheaths and catheters, and to evaluate their results.

PATIENTS AND METHODS

From January 2001 to December 2002 we performed 11 diagnostic and five interventional procedures in 15 infants, utilising 3 French sheaths and catheters. Inclusion criteria were: need for arterial catheterisation in patient weighing ≤ 4 kg, or need for venous catheterisation in patient < 3 kg. The median age and weight of the patients were 7 days (range 1–180 days) and 2.8 kg (range 2–4 kg), respectively. Diagnosis and type of procedure are listed in table 1.

IVA valve sheaths (Balt, Montmorency, France) are made of high density polyethylene and have a low coefficient of friction. The sheath is adjusted on the dilator for a non-traumatic use. It is supplied with a guide of 0.018 inch diameter. Introduction over the wire does not need skin incision.

The custom made 3 French angiography catheters (Balt, Montmorency, France) are made of polyamide. This material has high pressure tolerance and low pliability. Diagnostic catheters used were NIH, pig tail, and Judkins right, and were each 50 cm in length. The distal end of the pig tail was modified in order to have distal, close holes and a tail measuring 5 mm in diameter. For interventional procedures we utilised the mini Ty Shak balloon (Numed Inc, Hopkinton, New York, USA).

The pressure/output relation of the 3 French catheters were tested in vitro utilising the same contrast medium employed in vivo (Ultravist) and a Medrad Mark V injector.

Diagnostic and interventional catheterisations were performed using standard techniques, utilising a Judkins right catheter for right diagnostic catheterisation and an NIH or pig tail catheter for left catheterisation.

All patients underwent ultrasound evaluation of femoral vessels at a median follow up of 77 days (range 10–210 days). All ultrasound studies were performed with an Esaote Megas echograph. A 9.0 MHz transducer was placed approximately 1 cm below the inguinal ligament, medial to the pulsation of the femoral artery. Long and short axis images of the femoral artery and vein were obtained. The femoral arterial dimension was measured at its point of maximal expansion between the endothelial lines. The diameter was expressed as a ratio: cannulated versus non-cannulated vessel. Doppler interrogation was performed at multiple sites along the

femoral artery. Data for each patient comprised the mean of five consecutive measurements.

RESULTS

Diagnostic catheterisation obtained the required information in all cases. Following the results of an in vitro test, injection of 4–6 ml over one second at 300 and 800 Psi, respectively, resulted in good visualisation of the ventricular cavities and/or large vessels. Blood sampling was possible by using gentle aspiration. Pressure measurement enabled the evaluation of peak to peak gradient through right and left ventricular outflow. When required, it was always possible to perform an interventional procedure. Selective coronary angiography was also possible.

No complications were observed.

The price of a diagnostic or interventional procedure performed with a 3 French sheath and catheter cost €23 (£16) more than a procedure using material measuring 4 French or more.

At follow up all the vessels of the examined patients were patent, without stenosis or collateral circulation.

DISCUSSION

Development in interventional catheterisation and cardiac surgery has led to early treatment of most congenital heart diseases. Progressive miniaturisation of diagnostic and interventional tools has enabled diagnostic and interventional procedures to be undertaken in neonates and infants. However, vascular complications after cardiac catheterisation or cardiac surgery are still frequent.³ The incidence of arterial occlusion after neonatal femoral catheterisation varies between 30–45%^{1,3,4}; thus, in neonates, interventional catheterisation through an arterial approach is not advised. Limitation of sheath size is of major concern in infants weighing less than 3 kg, because of limited vascular access. A high incidence of femoral occlusion has been demonstrated in low weight neonates undergoing arterial catheterisation.² Preservation of femoral vascular access is mandatory in order to avoid a possible impaired limb growth⁴ and allow future catheterisations. It has been shown that the size of a normal femoral vein and femoral artery in neonates does not exceed 1.5 mm.⁵ Commercial sheaths are usually defined in accordance with their internal lumen. Thus, a 4 French sheath allows the introduction of a 4 French catheter, but its external lumen measures 2 mm, with minor variations for different products. It follows that a 4 French sheath completely occludes the lumen of a normal femoral artery or vein of a neonate.

Our results show that diagnostic and interventional investigations can be performed in newborns utilising 3 French sheaths and catheters without any acute complication.

The major advantage related to the use of this material concerns the ratio of external sheath lumen to diameter of the femoral vessel. Even if still close to 1, this improved ratio

Table 1 Patient characteristics and haemodynamic procedures

n	Diagnosis	Days	Weight (kg)	Vascular access	Pressure measurement	Blood sampling	Angiography	Interventional procedure
1	Shone syndrome	1	2.5	FA	Yes	Yes	Aorta	Aortic isthmus dilation
2	TA, PA, discontinuous Pas	5	2	FA	No	Yes	LV, aorta	No
3	Tetralogy of Fallot + azygos continuation	21	2.4	(FV), FA	No	Yes	LV and RV	No
4	Tetralogy of Fallot	11	2.8	FA	No	Yes	LV, RV, coronary arteries	No
5	Aorto-pulmonary window	180	4	FA	No	Yes	Aorta, coronary arteries	No
6	Tetralogy of Fallot	60	3.8	FA	No	Yes	LV, RV, coronary arteries	No
7	Single ventricle + PA	1	3	FA	No	Yes	LV, aorta	No
8	Pulmonary atresia + VSD	7	3	FA	No	Yes	LV, aorta	No
9	Tetralogy of Fallot	8	2.7	FA	No	Yes	LV, RV, coronary arteries	No
10	VSD with PH	45	4	(FV), FA	Yes	Yes	LV	No
11	Pulmonary stenosis	9	2.4	FV	Yes	Yes	RV	Pulmonary valve dilation
12	Shone syndrome	3	2.7	FA	Yes	Yes	Aorta	Aortic valve and aortic isthmus dilation
13	Aortic stenosis	3	3	FA	Yes	Yes	Aorta	Aortic valve dilation
14	Pulmonary atresia + VSD	180	2.8	FA	No	Yes	Aorta, MAPCAs	No
15	Interrupted aortic arch	6	3.2	(FV),FA	No	Yes	Aorta	No

FA, femoral artery; FV, femoral vein; (FV), femoral vein when cannulated with a 4 French sheath; LV, left ventricle; MAPCAs: major aorto-pulmonary collateral arteries; PA, pulmonary atresia; Pas, pulmonary arteries; PH, pulmonary hypertension; RV, right ventricle; TA, tricuspid atresia; VSD, ventricular septal defect.

should allow limb perfusion during catheterisation and reduce wall trauma.

Echocardiographic results are encouraging and should allow the indications for arterial catheterisation in newborns to be extended, and, in particular, should authorise the retro-grade approach for treatment of aortic stenosis and coarctation.

Arterial interventional catheterisation through 3 French sheaths could also be advisable after the neonatal period.

The financial implications of using 3 French material are not a major concern, and should be minimised by a more extensive use of this material.

However, the concern raised over the quality of angiography and pressure measurements obtained through 3 French catheters could limit their use to procedures that do not require an angiographic diagnosis. It is possible that further improvements in radiation technology could abolish the need for rapid high volume injections to obtain high quality images. In addition, the possibility of reliable pressure measurement through a small lumen catheter is under development.

Authors' affiliations

G Agnoletti, Y Boudjemline, Y Aggoun, I Szezepanski, D Bonnet, D Sidi, Service de Cardiologie Pédiatrique, Necker Enfants Malades, Paris, France

E Largen, Balt, Montmorency, France

Correspondence to: Dr Gabriella Agnoletti, Service de Cardiologie Pédiatrique, Groupe Hospitalier Necker Enfants Malades, 149, rue de Sévres, 75743 Paris, France; gabiella.agnoletti@nck.ap-hop-paris.fr

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