Percutaneous femoral arterial and venous catheterisation during neonatal intensive care

S P Wardle, A W R Kelsall, C W Yoxall, N V Subhedar

Abstract

***Background*—Femoral vessel catheterisation is generally avoided in the neonatal period because of technical difficulties and the fear of complications.**

***Aim*—To review the use of femoral arterial and venous catheters inserted percutaneously on the neonatal intensive care unit.**

***Methods*—Infants admitted to one of two regional neonatal intensive care units who underwent femoral vessel catheterisation were identified. Information collected included basic details, indication for insertion of catheter, type of catheter and insertion technique, duration of use, and any catheter related complications.**

***Results*—Sixty five femoral catheters were inserted into 53 infants. The median gestational age was 29 weeks (range 23–40). Twenty three femoral arterial catheters (FACs) were inserted into 21 infants and remained in situ for a median of three days (range one to eight). Twelve (52%) FACs remained in place until no longer required, and four (17%) infants developed transient ischaemia of the distal limb. Forty two femoral venous catheters (FVCs) were inserted into 40 infants and remained in situ for a median of seven days (range 1–29). Twenty seven (64%) FVCs remained in place until no longer required, and eight (19%) catheters were removed because of catheter related bloodstream infection.**

***Conclusions*—FACs and FVCs are useful routes of vascular access in neonates when other sites are unavailable. Complications from femoral vessel catheterisation include transient lower limb ischaemia with FACs and catheter related bloodstream infection.**

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Department of Child Health, University of Liverpool, Liverpool Women's Hospital, Liverpool, UK
S P Wardle

Neonatal Intensive Care Unit, Rosie Hospital, Addenbrooke's Hospital, Cambridge, UK
A W R Kelsall

Neonatal Intensive Care Unit, Liverpool Women's Hospital
C W Yoxall
N V Subhedar

Correspondence to:
Dr Subhedar, Neonatal Intensive Care Unit, Liverpool Women's Hospital, Crown Street, Liverpool L8 7SS, UK
nvsubhedar_lwh@yahoo.com

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The choice of vascular access in the neonatal period is often dictated by the severity of illness and the expected duration of the proposed treatment. Peripheral venous and arterial catheters are usually used but have a relatively short life and may result in extravasation injuries and ischaemic complications respectively.[1] When prolonged stable access is required, the umbilical arteries and vein provide an alternative route for vascular access. Longer term venous access can be obtained with fine percutaneous intravascular central catheters.[2] The insertion of these catheters is more difficult, and there is a higher incidence of sepsis than with the use of peripheral intravenous catheters.[3] When these routes have been exhausted, central venous catheters may be inserted surgically, but this often requires transfer to another hospital with specialist neonatal surgical and anaesthetic expertise. In an emergency, temporary vascular access can also be obtained by the intraosseus route.[4]

Loss of venous access can be a significant problem when infants require long term intravenous treatment and nutrition. Failure to establish arterial access precludes continuous invasive monitoring of blood pressure and sampling of arterial blood gas, both of which are desirable in the management of ventilated neonates.[5]

The use of the femoral artery and vein for vascular access has traditionally been discouraged in neonates. Proximity to the groin is thought to increase the risk of infection. Intermittent puncture of the femoral vein may predispose to septic arthritis of the hip.[6] The femoral artery is an end artery, and thromboembolic complications may produce distal ischaemia of the lower limb. Despite these theoretical concerns, the femoral vessels are often used during cardiac catheterisation, even in neonates, and the reported incidence of complications is low.[7]

Case series have been reported of femoral venous catheters inserted into neonates after surgical dissection[8 9] or percutaneously through a needle.[10 11] To our knowledge, there are no reports on the use of modern catheters introduced into the femoral vessels using the Seldinger technique in neonates. We report our experience of the use of femoral arterial catheters (FACs) and femoral venous catheters (FVCs) during neonatal intensive care when alternative routes of access were unavailable.

Methods

Infants in whom an FAC or FVC was inserted were identified from two regional neonatal intensive care unit databases. Femoral catheters were inserted at the discretion of the clinician. Information was collected on the following: gestational age, birth weight, age and weight at insertion, reasons for insertion, duration in situ, complications, and indication for removal. Catheter related bloodstream infection was diagnosed when catheter and peripheral blood cultures were both positive for the same organism. Such infection was managed by either treatment with appropriate antibiotics through the catheter or its removal.

All the catheters were inserted by one of four trained operators who were experienced in the insertion technique. All FVCs and most FACs were inserted aseptically using the Seldinger

Table 1 Patient details

	Femoral venous catheters (n=42)	*Femoral arterial catheters (n=23)*
Gestational age (weeks)	32 (23–40)	27 (23–37)
Birth weight (g)	1713 (474–3710)	845 (550–3480)
Age at insertion (days)	24 (1–140)	3 (1–112)
Weight at insertion (g)	2265 (452–6600)	1002 (550–6600)
Duration in situ (days)	7 (1–29)	3 (1–8)

Each variable is expressed as median (range).

technique described below.[12] In a small number of infants, femoral artery catheterisation was performed using a 24G cannula alone without another catheter being introduced over a guidewire. All infants had platelet counts above 50×10^9/l, with normal coagulation studies. Ventilated infants were sedated with morphine sulphate (100 μg/kg intravenously) sometimes in combination with a muscle relaxant. Non-ventilated infants were sedated with either chloral hydrate (50 mg/kg orally or rectally) or ketamine (2 mg/kg intramuscularly). Local anaesthetic use depended on the operator. The inguinal region was cleaned using aqueous chlorhexidine and a sterile field established. The femoral artery was identified below the inguinal ligament as the key landmark. Several different types of central venous catheters are available and come prepackaged with all the equipment necessary for insertion. The following types of catheter were used: 20G 8 cm Leadercath and 22G 6 cm Leaderflex (Vygon, Aachen, Germany); 24G Jelco Cannulae (Johnson & Johnson, Arlington, USA); Careflow 18G 10 cm (Becton Dickenson, Franklin Lakes, USA). The catheter length and number of lumens was chosen to suit the clinical circumstance.

SELDINGER TECHNIQUE

The insertion technique and anatomical landmarks have been described previously.[10] The femoral vessels were initially catheterised from just below the inguinal ligament advancing either a 20G introducer needle or a standard 22G intravenous cannula through the skin at an angle of 30–45° in the direction of the umbilicus. The initial point of entry was either just above the femoral arterial pulse (for FACs) or just medial to it (for FVCs). Correct placement of the introducer needle or catheter was confirmed by the aspiration or free flow of blood. A guide wire was then introduced into the vessel and the needle or catheter removed with care to avoid dislodging the wire. The catheter was threaded over the wire and the guidewire removed. Aspiration of blood through the catheter confirmed successful insertion.

Catheters were sutured and/or secured in position using adhesive strips and covered with a transparent dressing. The site of insertion and the lower limb were inspected regularly to identify complications such as bleeding, venous engorgement, or ischaemia. When limb ischaemia was identified, catheters were removed within a few minutes. All catheters were connected to infusion pumps with Luer locked infusion tubing, and heparinised fluid was used for all infusions. In multilumen catheters, ports not being used were regularly flushed with heparinised saline to maintain patency.

Table 2 Details of the cases in which femoral arterial catheters were used

Subject	*Postnatal age (days)*	*Weight (g)*	*Gestational age (weeks)*	*Length of time catheter in place (days)*	*Reason for removal and complications*
1	23	550	23	2	Blocked, died later
2	12	576	24	3	No longer required, died later
3	10	635	25	3	Blocked, died later
4	2	642	25	2	Limb ischaemia, resolved when catheter removed
5	4	657	26	3	Died
6	2	680	26	7	Limb ischaemia, resolved when catheter removed
7	2	758	29	7	No longer required
8	1	758	29	6	No longer required, died later
9	30	778	24	2	Died
10	3	845	28	4	No longer required
11	1	990	27	1	Blocked, died later
12	3	990	27	1	Died
13	23	1013	24	1	Limb ischaemia, resolved when catheter removed
14	84	1569	26	4	Blocked, died later
15	3	2000	34	5	Blocked, died later
16	1	2330	37	2	No longer required
17	19	2492	35	2	Blocked
18	1	2590	35	2	No longer required
19	7	2656	35	1	Limb ischaemia, resolved when catheter removed
20	73	2870	27	8	No longer required
21	3	3168	37	6	No longer required
22	2	3370	35	2	Fell out
23	112	6600	33	7	Died

Results

A total of 23 FACs and 42 FVCs were placed in 53 infants. Table 1 shows details of the patients, and tables 2 and 3 give details about the FACs and FVCs inserted respectively. Four infants had FACs and FVCs in situ simultaneously, and several infants had FACs and/or FVCs inserted on two or more separate occasions. Seventeen (30%) of the infants died, but none of these deaths was caused by the femoral vessel catheterisation.

Femoral arterial catheterisation was associated with transient ischaemia of the distal limb in four cases (17% (95% confidence interval 5 to 38%)), but in all cases perfusion was rapidly restored once the catheter was promptly removed. There were no cases of gangrene (0% (95% confidence intervals 0 to 15%)). No cases of catheter related bloodstream infection were associated with FAC insertion. Six (26%) arterial catheters were removed because of blockage. One catheter was accidentally dislodged without significant haemorrhage. The remaining 12 (52%) catheters were removed when no longer required.

Femoral venous catheterisation was associated with venous engorgement of the distal limb in six cases (14%). The swelling resolved completely within a week of catheter removal. Nine catheters (21%) were associated with *Staphylococcus epidermidis* positive blood cultures; eight of these catheters were removed. Nine catheters (21%) were removed because of blockage, and only one venous catheter was accidentally dislodged. In five (12%) cases, a new catheter was resited over a guidewire, prolonging access through the femoral vein. Twenty seven (64%) of the venous catheters remained in place until they were no longer required.

Table 3 Details of the cases in which femoral venous catheters were used

Subject	*Postnatal age (days)*	*Weight (g)*	*Gestational age (weeks)*	*Length of time catheter in place (days)*	*Reason for removal and complications*
1	13	452	24	1	Blocked
2	20	550	23	2	No longer required, died later
3	2	576	24	8	Line related sepsis, died later
4	12	576	24	3	No longer required, died later
5	3	600	24	7	Line related sepsis, died later
6	13	608	25	1	Blocked
7	22	650	24	13	Line related sepsis
8	75	758	29	15	No longer required, died later
9	46	825	29	29	Venous engorgement, sepsis
10	30	1022	26	5	Blocked
11	84	1569	26	9	Sepsis, died later
12	2	1596	33	5	Died
13	86	1553	25	6	Transient venous engorgement
14	40	1699	28	10	No longer required
15	75	1761	26	5	Blocked, venous engorgement, sepsis
16	58	1800	28	4	No longer required
17	75	1829	29	15	No longer required, died later
18	62	1850	28	7	No longer required
19	8	2000	32	17	Transient venous engorgement
20	7	2190	32	3	Fell out, died later
21	6	2200	37	12	No longer required
22	49	2200	32	13	No longer required
23	1	2330	37	2	No longer required
24	22	2368	34	6	Line related sepsis
25	22	2560	33	15	Transient venous engorgement
26	8	2656	35	9	No longer required
27	3	2800	36	3	Fell out
28	33	2800	37	4	No longer required
29	50	3100	33	18	Transient venous engorgement
30	8	3156	38	4	Blocked
31	3	3168	37	6	No longer required
32	3	3202	37	4	No longer required
33	131	3351	31	10	Infection, died later
34	140	3400	27	5	No longer required
35	2	3400	37	5	Fell out
36	124	3600	26	8	No longer required
37	25	3750	39	9	No longer required
38	29	3840	39	5	No longer required
39	2	3850	40	12	Line related sepsis, died later
40	100	3870	26	12	Local erythema, removed when no longer required
41	32	4300	39	26	No longer required
42	112	6600	33	7	Died

Discussion

We here report our experience of the use of FACs and FVCs in two regional neonatal intensive care units. There were no major complications from the use of these catheters, and minor complications were relatively rare and in all cases resolved rapidly.

Even though there were no major catheter related complications in this study, we cannot rule out the possibility of serious and therefore clinically important complications occurring occasionally. Gangrene and loss of the lower limb have been reported previously with the use of FACs in children, and the incidence of this complication in very low birthweight infants is likely to be higher. Femoral catheters have not been used widely in extremely low birthweight infants in the past because of the expected risks. We did not show a high incidence of adverse effects, but catheterisation of infants weighing less than 1000 g did not last for long periods, often because infants died for reasons unrelated to their vascular catheters. The inevitable high mortality in this group means that the incidence of medium and long term complications cannot be determined, and follow up of these infants is therefore important.

In general, FACs were inserted early in the course of respiratory illness (median age three days), when invasive blood pressure monitoring and/or arterial blood sampling were deemed essential for clinical management. In contrast, FVCs tended to be inserted later (median age 24 days), to provide secure long term venous access when other routes were no longer available. They remained in place for longer than FACs (median of seven days versus three days), presumably because intra-arterial catheters were removed once an infant's cardiorespiratory status had stabilised.

In our series, although the complication rate with FVCs was relatively high, the complications were usually minor. Transient limb engorgement and catheter related bloodstream infection were the most common problems. This is in keeping with other studies reporting complications with central venous catheters in neonates[13 2] and with other reports of the use of percutaneous FVCs using a different insertion technique.[10 11] The complication rate with FACs was similar to that with FVCs, with transient distal ischaemia and catheter blockage occurring most commonly. All the complications described above were reversible and responded to removal of the catheter or appropriate treatment. Overall, in difficult circumstances in which no alternative vascular access was readily available, over half of all FVCs and FACs remained in situ until they were no longer required. We acknowledge that one limitation of our study is the lack of a control group of infants in whom alternative vascular access was used. By definition, our study population was one in which no such vascular routes were available, and therefore there could be no directly comparable control group. Instead we chose to compare our complication rates with those previously described in the literature.

All cases of catheter related bloodstream infection occurred in infants with FVCs. This is probably because FVCs were used for older infants than were FACs and remained in situ for longer, thus increasing the risk of infection. Infants with catheter related bloodstream infection responded to appropriate antibiotic treatment and/or catheter removal. No cases of septic arthritis of the hip were identified in this series.

There are several case reports describing the use of FVCs in neonates. Hogan and Pulito[8] described the surgical cut down insertion of Broviac catheters through the saphenous and femoral veins under local anaesthetic in 84 infants, and Meland *et al*[9] reported the use of a similar technique in a series of 35 neonates. In these series, complications occurred in about 50% of cases, but 62–83% of catheters remained in situ until no longer required. There are two reports of percutaneous femoral venous catheter insertion using a modified Seldinger technique with a fine catheter threaded through an introducer needle. In the first study, silastic catheters were inserted into 44 infants;[10] in the other, silicone rubber catheters were inserted into 63 infants.[11] The incidence of complications in both studies was small, with most catheters being removed electively. Our report is different from these studies in a number of ways. Firstly, all FVCs and most FACs were inserted using the standard

Seldinger technique. We have also described femoral catheterisation in a much smaller and more immature group of infants than that previously reported. Furthermore, in our series, the femoral route was only used as a last resort in sick babies when no alternative vascular access was available.

This study illustrates that FACs and FVCs can be used to obtain vascular access and permit continuous invasive monitoring in sick neonates when other routes have failed or been exhausted. As no major complications occurred in this series, we conclude that the risk of serious adverse events with this technique is low in experienced hands. This study provides support for the use of femoral vessel catheterisation in newborn infants. We would recommend that insertion of femoral catheters in the neonate should only be performed by trained experienced personnel.

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