Brief Reports

Vascular Access in Pediatric Hemodialysis

Rosalyn Kurien
Jacob George
Chakko K. Jacob
J.C.M. Shastry

Difficulty in obtaining a satisfactory vascular access is a major problem in pediatric hemodialysis(l,2). Though short term hemodialysis can be achieved by catheterisation of the major veins(3), they are prone to complications like thrombosis and infection and may not be ideal for long term use(2,4). Arteriovenous(AV) fistula, though ideal in adults undergoing long term hemodialysis(5)/ are technically difficult to create in children and require a prolonged period for maturation(l). Arterio-venous (AV) shunts, besides being prone for thrombosis(2), have a potentially lethal complication of separation of the arterio-venous connector in hyperactive children(1). We report our experience in children with various techniques for vascular access.

Subjects and Methods

A retrospective analysis of the duration, course and complications of various techniques for vascular access used in children, undergoing hemodialysis for at least 2 weeks, during January 1989 to June 1993 was done. Vascular access included femoral and subclavian catheters, AV shunts and AV fistula. Cannulation of the femoral and subclavian veins was done by by the Seldinger method(6). A double-lumen catheter (Quinton-Mahurkar, USA; size 13.5 cm, 11.5 F) was used for all subclavian and three cases of femoral catheterization while 2 single-lumen femoral catheters (Medcomp, USA; size 14 cm, 12 F) were used in the rest. AV shunts were performed by the method described by Quinton(7). A curved soft silastic tubing with Teflon coated vessel tips was used. The size of the vessel tips varied between adult size (17 to 19 F) and occasionally pediatric size (18 to 20 F). When pediatric vessel tips were inserted, a straight silastic shunt tube was used. AV fistulae were created by either anastomosing the brachial artery or the radial artery to the cephalic vein after an initial AV shunt had been created to enlarge the veins as described earlier(8). Maintenance hemodialysis, after an initial intensive hemodialysis, was usually of 3 hr duration and was given thrice weekly.

Statistical analysis was done using the Chi-square and Students 't' test.

From the Department of Nephrology, Christian Medical College, Vellore.

Reprint requests: Dr. Jacob George, Lecturer, Department of Nephrology/, Medical College Hospital, Trivandmm 695 011
Received for publication: April 21, 1995; Accepted: March 4, 1996

Results

Thirty children with ages ranging from 6 to 14 yr (mean 11.3 ± 2.3 yr) and weight ranging from 17 to 38 kg (mean 26 ± 7.8 kg) were studied. The male to female ratio was 2:1. Fifty three various vascular accesses were done, with more than one access in 17 patients. All patients had end stage renal disease (ESRD), except 4 who had acute renal failure. The patients with acute renal failure recovered within a mean period of 19 ± 7.3 days. Of the patients with ESRD, 12 underwent renal transplantation while the rest discontinued hemodialysis. The patients underwent a mean of 35.6 ± 22.7 hemodialysis (range 8 to 118). Details of complications and life span of vascular access are shown in *Table I.*

TABLE I–*Type of Vascular Access, Complications and Outcome*

	Femoral catheter (n=11)	Subclavian catheter (n=7)	Radiocephalic shunt (n=28)	Radiocephalic fistula (n=1)	Brachiocephalic fistula (n=6)
Age (yr)	10.3 ± 2.7	11.5 ± 2.3	9.8 ± 3.5	12	9.2 ± 2.7
Weight (kg)	19 ± 4.3	22.5 ± 5.3	23.7 ± 5.7	19	22.8 ± 4.6
Access failure	6	3	12	–	–
Causes of access failure					
infections	3	1	3	–	–
thrombosis	3	–	8	–	–
dislodgement	–	1	–	–	–
bleeding	–	1	1	–	–
Infections managed conservatively	2	–	5	–	–
Elective removal	5	4	16	1	6
Life of access* (days)	13 ± 4.2	34.2 ± 9.2	47.7 ± 18.6	50	86.5 ± 19.6
Mean blood flow (ml/mt)	120	130	150	150	170
Mean venous pressure (mm Hg)	54	44	45	55	68

* Refers to well-functioning access.

Infections occurred in 14 cases after a mean duration of 12.6 ± 7.2 days. Seven of these infections were managed conservatively with appropriate antibiotics and daily dressings, while the access had to be removed in the rest. *Staphylococcus aureus* was cultured from the catheter type in 6 patients and *enterococcus* and coagulase negative *Staphylococcus* in one each. Six femoral and 3 subclavian catheters were removed, because of complications, within a mean period of 11.2 ± 3.9 and 25.6 ± 5.7 days respectively. Complications necessitated removal of 12 AV shunts within 68.5 ±11.7 days, while none were seen with AV fistulae, though this was not statistically significant. Access life was significantly more with AV shunts and AV fistulae ($p < 0.01$). The mean maturation time for brachial fistulae was 36.4 ± 8.3 days while the radial AV fistulae could be used immediately as it was constructed following an initial AV shunt.

Discussion

Femoral catheters were only used in patients where acute renal failure was suspected or when patients with ESRD presented with complications like pulmonary edema or as a temporary access while another access was being planned. As it is technically easy to introduce a femoral catheter even in patients who cannot lie down flat, it is the access of choice in pulmonary edema(9). However, long term hemodialysis through this access is often not possible due to complications like infections, thrombosis or occasional dislodgement(l0). Adequate preparation of the skin with povidone iodine and careful handling of the catheter during dialysis reduces the incidence of infection(ll). Despite this, we could obtain a mean access life of less than 2 weeks, with complications like infection and thrombosis occurring in the majority. Subclavian catheters require more skill to insert and are not advised in patients with pulmonary edema(9). They however have a longer access life than femoral catheters and can be used for an average of 7 weeks (12). We have often used a subclavian catheter and found the mean access life to be around 5 weeks.

AV shunts were the first vascular access tried in chronic hemodialysis(7). Complications include thrombosis, infection and ischemia(2) and occasional heart failure(13). In the child, a potentially lethal complication of separation of the arterio-venous connector during increased activity has been reported (l). We, however, did not see any case of disconnection probably as we used curved shunt tubes rather than straight ones. In five of our patients a single AV shunt was the sole access performed till transplantation.

An AV fistula is considered to be the access of choice in an adult undergoing chronic hemodialysis(5). In children, however, the small size of the blood vessels make this technically difficult, though microsurgical techniques have enhanced the success rate(14). While a maturation period of 3 to 4 weeks is required before a fistula can be used in adults(8), this is more than double in children(15) and can even take as long as 6 months(l). This problem can be overcome by initially creating an AV shunt and later converting it into an AV fistula when the veins become partially arterialized and dilated (8). Though this procedure makes the vein enlarge the artery size remains the same. A brachial AV fistula has a higher success rate if the radial artery is too small. Of 7 AV fistulae in this study, 6 were constructed, using the brachial artery. Complications of AV fistula include high output cardiac failure (13), distal ischemia(2) and differential limb growth(l). Repeated needle punctures are, however,

required in AV fistulae and can make children dread the procedure(4).

Other modes of vascular access used include femoropopliteal arterial grafts using polytetra-fluoro ethylene grafts(l) and Hickman catheters(15). Both these can be used in children as small as 9 kg where creating other vascular access could be difficult. We, however, have not had experience with these.

REFERENCES

1. Robinson HB, Wenzl JE, Williams GR. Internal vascular access for hemodialysis in children weighing less than fifteen kilograms. Surgery 1979, 85: 525-529.
2. Buselmeier TJ, Santiago EA, Simmons RL, Najarian JS, Kjellstrand CM. Arterio-venous shunts for pediatric hemodialysis. Surgery 1971, 70: 638-646.
3. Kon V, Harmon WE, Levey RH, Groupe WE. Short and long term dialysis in ambulatory pediatric patients by subclavian catheter. Kidney Int 1981, 21:171-173
4. Idriss FS, Nikaidok LR, King R, Swenson O. Arteriovenous shunts for hemodialysis in infants and children: J Pediatr Surg 1971, 6: 639-644.
5. Brescia MJ, Cimino JE, Appel K, Hurwich BJ. Chronic hemodialysis using venipuncture and a surgically created arteriovenous fistula. N Eng J Med 1966, 275: 1089-1092.
6. Shaldon S, Chiandussi L, Higgs B. Hemodialysis by percutaneous catheterization of the femoral artery and vein with regional heparinisation. Lancet 1961, 1:857.
7. Quinton WE, Dillard D, Scribner BH. Cannulation of blood vessels for prolonged hemodialysis. Trans Am Soc Artif Intern Organs 1960, 6:104-107.
8. S. Murthy MLN, Niyamathullah MM, Hariharan S, Kirubakaran MG, Shastry JCM. Conversion of arteriovenous shunts to fistulae for maintenance hemodialysis. J Assoc Physicians India 1989, 37: 220-221.
9. Uldall PR. Temporary vascular access for hemodialysis. *In:* Dialysis therapy, 2nd edn. Eds. Nissenson AR, Fine RN. Philadelphia, Hanley and Belfus, 1992, pp 5-10.
10. Kjellstrand CM, Merino GE, Mauer SM, Casali R, Buselmeier TJ. Complications of percutaneous femoral vein catheterization for hemodialysis. Clin Nephrol 1975, 4: 37-40.
11. Dominic X, D'Souza F, Muralidharan, e*t al.* Incidence and source of femoral catheter related infections: a prospective study. Indian J Nephrol 1994, 4: 78-80.
12. Jha CM, Chhatree P, Gulati PD. Subclavian catheterisation as an angioaccess for hemodialysis-experience with 500 cannulations. Indian J Nephrol 1994, 4: 98.
13. Ahearn DJ, Maher JF. Heart failure as a complication of hemodialysis arteriovenous fistula. Ann Intern Med 1972, 77:201-203.
14. Hardy MA, Schneider KM, Levitt SB. An improved technique for the construction of internal arteriovenous fistula in uremic children. J Pediatr Surg 1974, 9: 465-467.
15. Mahan JD, Mauer SM, Nevins TE. The Hickman catheter: A new hemodialysis access device for infants and small children. Kidney Int 1983, 24: 694-697.