MICROSURGERY FOR HAEMODIALYSIS DISTAL ARTERIOVENOUS FISTULAE IN CHILDREN WEIGHING LESS THAN 10kg

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Summary

Between 1977 and 1981, 30 distal arteriovenous fistulae have been created in 22 children weighing less than 10kg. With microsurgical techniques the rate of immediate patency was 90%. Fifteen fistulae had a maturation sufficient for haemodialysis, sometimes after secondary superficialisation of the vein. The evolution of six fistulae could not be evaluated either because of the death of the child shortly after operation or because the anastomosis was too recent. Nine fistulae failed because of immediate or secondary thrombosis and lack of maturation.

Introduction

The creation of vascular access for haemodialysis in children is difficult because of the small calibre of their blood vessels, particularly at the wrist.

Robinson, Wenzl and Williams [1] advocate, when body weight is below 15kg, the construction of a femoropopliteal jump graft using a polytetrafluoroethylene prosthesis placed subcutaneously in the thigh. This method can be used in very small children (3.8 to 16kg) whose vessel size prevents conventional techniques for vascular access. It allows cannulation within one week. However Robinson et al [1] report two occlusions and two false aneurysms of the graft in five patients. There is also the increased risk of infection due to multiple punctures of subcutaneous foreign material.

Kinnnaert, Janssen and Hall [2] recommend the creation of an elbow fistula. The median cephalic vein is anastomosed to the brachial artery. Intermittent peritoneal dialysis can be used until the calibre of the cephalic vein allows puncture in the arm. The delay between creation of the vascular access device and the first haemodialysis was reported as 4 to 8 weeks in 7 children whose mean weight was 15kg. The only complication was a clotting episode during an orthopaedic surgical procedure. A proximal arteriovenous fistula may lead to high output cardiac failure. The procedure was not used in children weighing less than 10kg.
In addition this surgical procedure requires venous ligatures at the elbow which may preclude future construction of a distal arteriovenous fistula.

We believe that a distal arteriovenous fistula, which is considered as the best internal vascular access, can be created even in children weighing less than 10kg with the help of microsurgery. Since 1977, 30 vascular accesses were created in 22 such children with the aid of an operating microscope.

Methods

Preoperative clinical evaluation of the radial artery is easy to perform with the help of a Doppler apparatus. Evaluation of the cephalic vein, however, is much more difficult because of the thickness of the subcutaneous tissue in very young children. A venogram is necessary to assess the vein from wrist to elbow and the adequacy of the run-off proximally. It may have been damaged, chiefly at the elbow, by repeated punctures or by previous vascular access procedures thereby precluding the creation of distal arteriovenous fistulae in both forearms.

Surgery is performed under general anaesthesia. The operating microscope is a Zeiss OPMI 6D with fibreoptic light source; translation (X–Y device), motorised focusing and zoom magnification are controlled with a foot pedal. Gentle dissection is very important to avoid spasm. External arterial diameter varies from 0.8 to 1.2mm, vein diameter varies from 1 to 1.6mm. The anastomosis is side (radial artery) to end (cephalic vein) at the wrist; the length of the incision in the radial artery is made equal to three times the circumference of the cephalic vein which is bevelled; in few cases the anastomosis is with the ulnar artery; vessels are not dilated and heparinised only between the Acland clamps; microsutures are 10–0 BV8 Ethilon; running stitches are used, except at the extremities of the anastomosis. A sterile Doppler probe is placed on the vein to check the permeability of the fistula. In these small children the continuous murmur may not be audible during the first postoperative hours and patency has to be checked by transcutaneous Doppler examination. A secondary procedure may be necessary some weeks later: refashioning of the anastomosis and/or superficialisation of the vein at the forearm.

Patients

Between January 1977 and June 1981, 30 distal arteriovenous fistulae have been created in 22 children (Table I) using microsurgical techniques. Twenty-seven employed the radial artery at the wrist, and three the ulnar artery.

Secondary surgical procedures were necessary six times to obtain an available

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<td>Number of children: 22</td>
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<td>Mean weight: 8.01kg (4.60 to 10.00)</td>
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<td>Mean age: 25 months (8 to 60)</td>
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<td>Reoperations: 6</td>
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fistula in due time for dialysis: 1 reformation of the anastomosis, 1 correction of proximal venous stenosis, 5 superficialisations of the vein.

Mean weight of the children was 8.01kg (4.60 to 10.00kg). Mean age was 25 months (8 to 60 months). Mean height was 73cm (60 to 82cm).

In eight children chronic haemodialysis had already been initiated on a more proximal arteriovenous fistula.

Results

Immediate patency

Immediate patency was obtained in 27 anastomoses. The three immediate thromboses were not reoperated.

Maturation

Fifteen fistulae expanded sufficiently to be used for dialysis. Six of them are accessible by needle puncture but have not yet been used; two children do not yet require dialysis, four children are on chronic ambulatory peritoneal dialysis or dialysed by a different vascular access constructed previously. Nine fistulae are or have been regularly used for haemodialysis; one has been used for seven months until a successful renal transplantation; one thrombosed after four months; seven have been in use for 1 to 33 months (mean = 15 months). The mean delay between operation and the first needle puncture of these nine fistulae was four months (15 days to 8 months). Secondary procedures were performed on six of these 15 fistulae (Table II).

<table>
<thead>
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<th>TABLE II. Results (30 distal fistulae)</th>
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<tr>
<td>Success</td>
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<td>Non-evaluable</td>
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<td>Failure</td>
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The evolution of six fistulae could not be evaluated: three were patent but the child died before beginning dialysis; three are recent and their ability to mature is uncertain.

Nine fistulae failed: three thrombosed immediately during surgical procedure; three thrombosed later before maturation; three never developed although remaining patent for several months.

Complications

Except thromboses and lack of maturation there were few complications. Venepuncture was rarely a problem. Infection was responsible for one post-operative thrombosis. Venous hypertension was observed once because of a poor run-off from the cephalic vein at the elbow. No child has developed excessive growth of
the extremity. No congestive heart failure, aneurysm formation or ischaemic symptoms in the extremity have been observed.

Discussion

Microvascular surgery is a recent and promising technique. Initial successes with microvascular surgery were first reported in digital re plantation and cerebral revascularisation. Microsurgery would appear to be particularly useful for distal arteriovenous fistula formation in very small children.


Gagnadoux et al [7] reported immediate thrombosis in 50% of distal fistulae in children under 20kg. The benefit of microsurgery is obvious from our series: all children weighed less than 10kg, nevertheless an immediate patency was obtained in 90% of the 30 fistulae.

Creation of a patent arteriovenous anastomosis is not sufficient. Some fistulae need secondary superficialisation of the vein when it is too deep. Secondary thrombosis was observed in 15% of 27 fistulae, one of which had been used for four months. Finally three fistulae remained patent but never developed, two of these were ulnar fistulae.

As a rule the fistula needs a long period (average six months) to mature before first needle puncture should be attempted. If the dilatation of the vein is not sufficient when dialysis has to be started, the child should be treated by peritoneal dialysis until repeated cannulations are possible.

The creation of a distal arteriovenous fistula is very important even if it matures more slowly than the proximal one as proximal incisions destroy venous run-off from the forearm precluding subsequent distal anastomosis.

The creation of a spare alternative distal arteriovenous fistula must sometimes be considered in small children, particularly for the very small, for those whose first access is uncertain and those for whom peritoneal dialysis is not possible.

References

1 Robinson HB, Wenzl JE, Williams GR. Surgery 1979; 85: 525
2 Kinnaert P et al. Surgery 1979; 86: 906
5 Arbus G, Sniderman S, Trusler G. Clin Nephrol 1974; 2: 68
6 Sicard G et al. Trans ASAIO 1978; 24: 695
7 Gagnadoux MF et al. J Urol Nephrol 1978; 84: 935
Open Discussion

DE SANTO (Napoli) Could you distinguish between the children in whom you had success and the failures? Is there a difference concerning body weight, degree of uraemia, GFR, age and blood pressure?

BOURQUELOT The only explanation we found for failures was that three of these distal AV fistulae were done on ulnar arteries. It is a smaller artery and maybe this was the reason. In the other cases I haven’t any explanation.

SCHÄRER (Chairman) Sometimes we are asked, as nephrologists, if it is possible to create a fistula in a small child without uraemia, e.g. for giving i.v. fluids after intestinal resection or in thalassaemia. Do you believe that your technique is also feasible in non-uraemic patients?

BOURQUELOT I have some experience with chemotherapy for children but not with such small children.