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Report on Blood Access for Hemodialysis in the Department of Transplantation, Tokai University School of Medicine and a Satellite Hospital

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There were 316 patients being treated by maintenance hemodialysis in the Department of Transplantation, Tokai University School of Medicine and its satellite hospital (Bohsei Clinic, Medical Treatment Cooperation, Showakai) as of December 31, 1981. Forty eight male (23.1%) and 39 female (35.7%) patients were operated on for external shunts. One case of external shunt was functioning well 48 months later. No patient was dialysed through external shunts on December 31, 1981 in our Department or the satellite.

The majority of patients, who were maintained on hemodialysis with an arteriovenous (native vein) fistula available, experienced no difficulties. Nearly 50 percent of cases with the first fistula were functioning on December 31, 1981. There were some complications with fistulas such as pseudoaneurysms, infections, the sore thumb syndrome or the steal syndrome.

We experienced 14 hemodialysis cases using expanded polytetrafluoroethylene (E-PTFE) grafts and one case using femoral artery repositioning as blood access.

(Key Words: Blood Access, Hemodialysis, External Shunt, Arteriovenous Fistula, E-PTFE)

INTRODUCTION

The availability of easily accessible arterial and venous channels has revolutionized the fate of countless individuals suffering from end-stage renal desease. The process began with the innovative external shunts pioneered by Quinton, Dillard, and Scribner (4) which subsequently underwent many modifications. Since 1966, the internal arteriovenous (A-V) fistula first described by Brescia and associates (1) has solved many problems of external shunts, the majority of which were primarily related to the presence of an intravascular transcutaneous foreign body. At present, the new renal failure patient receives a forearm radiocephalic A-V fistula: the cannula is restricted to emergency or short-term hemodialysis and may later be converted to a subcutaneous fistula.

This paper discusses blood access for hemodialysis in the Department of Transplantation, Tokai University School of Medicine and its satellite hospital (Bohsei Clinic, Medical Treatment Cooperation, Showakai).

MATERIALS AND METHODS

The number of patients treated by maintenance hemodialysis in the

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Department of Transplantation, Tokai University School of Medicine and its satellite hospital (Bohsei Clinic, Medical Treatment Coopration, Showakai) was 316 as of December 31, 1981. The male : female ratio was about 65.5 : 34.5% (Table 1).

Table 1 shows a comparison of the proportions of patients of different durations in the hemodialysis groups. The proportion of patients treated by hemodialysis for under 10 years showed few changes in males and females. There were only three male patients undergoing over 10 years of hemodialysis since this Department was opened in April, 1975. Patients who started hemodialysis before April, 1975 were submitted to induction hemodialysis in other hospitals.

In Table 2, patients treated by maintenance hemodialysis are classified according to age. We had no infants less than 10 years old treated by regular hemodialysis as of December 31, 1981. Patients more than 65 years old included 24 males (11.6%) and 19 females (17.4%). In December 31, 1981, there were four kinds of blood access for maintenance hemodialysis: external shunts, arteriovenous fistulas, E-PTFE grafts and femoral artery repositioning.

Table 1 Duration of hemodialysis in chronic renal failure patients.

Duration of HD* (years)	Number of patients	
	Male	Female
10<	3 (1.4%)	0 (0%)
5—10	52 (25.5%)	24 (22.0%)
4—5	21 (10.1%)	11 (10.1%)
3—4	28 (13.5%)	17 (15.6%)
2—3	31 (15.0%)	16 (14.7%)
1—2	37 (17.9%)	21 (19.3%)
1>	35 (16.9%)	20 (18.3%)
Total	207 (100%)	109 (100%)

*HD: hemodialysis

Table 2 Age of patients under hemodialysis

Age	Number of patients	
	Male	Female
65<	24 (11.6%)	19 (17.4%)
50～64	58 (28.0%)	41 (37.6%)
40～49	51 (24.6%)	25 (22.9%)
30～39	49 (23.7%)	17 (15.6%)
20～29	22 (10.6%)	4 (3.7%)
10～19	3 (1.4%)	3 (2.8%)
10>	0 (0%)	0 (0%)
Total	207 (100%)	109 (100%)

RESULTS

(1) External shunts

Table 3 shows the number of external shunt operations performed on patients treated by maintenance hemodialysis, i. e. 48 males (23.1%) and 39 females (35.7%). One male patient underwent external shunt operations seven times in 12 months.

Table 4 shows the duration of hemodialysis using external shuts. The great majority of external shunts were not functioning 12 months later. One external shunt was functioning well 48 months later. No patient was dialysed via an external shunt on December 31, 1981.

Table 3 Number of external shunt operations in each patient treated by hemodialysis

Frequency of Operations	Number of patients													
	65< *		50～64		40～49		30～39		20～29		10～19		Total	
	M	F	M	F	M	F	M	F	M	F	M	F	M	F
1	7	8	11	9	10	5	9	6	5	2	0	0	42	30
2	0	0	1	5	0	0	1	0	0	0	0	0	2	5
3	0	0	0	1	0	0	1	1	1	0	0	0	2	2
4	0	0	0	0	0	0	1	0	0	0	0	0	1	0
5	0	1	0	0	0	0	0	0	0	0	0	0	0	1
6	0	0	0	1	0	0	0	0	0	0	0	0	0	1
7	1	0	0	0	0	0	0	0	0	0	0	0	1	0

*Age groups of patients under hemodialysis
M: Male, F: Female

Table 4 Functioning periods of external shunts

Functioning period	Number of patients											
	65< *		50～64		40～49		30～39		20～29		Total	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
1 Week>	2	1	0	4	1	0	0	0	0	0	3	5
1 Month>	1	2	2	4	2	1	4	2	0	0	9	9
1～3 months	4	4	3	1	1	0	5	3	2	1	15	9
3～6 months	1	4	2	6	2	4	4	1	3	0	12	15
6～9 months	0	0	3	2	0	0	2	1	4	0	9	3
9～12 months	3	0	0	1	1	0	1	0	0	0	5	1
12～24 months	3	2	1	7	2	0	0	0	0	1	6	10
24 months	0	0	0	1	0	0	1	1	1	0	2	2

*Age groups of patients under hemodialysis

Numerous disadvantages of this shunt (repeated thromboses, frequent reopening and occasional decreased blood flow with dialysis failure) led us to look for another form of vascular access.

Table 5 shows the patients operated on for external shunts according to the period of hemodialysis. All patients on hemodialysis for over ten years (three cases) were operated on for external shunts. Recently, we tried shuntless hemodialysis with direct femoral vein punctures in cases of induction hemodialysis of chronic renal failure to maintain the native blood vessels intact.

External shunts were mainly located in the radial artery to the cephalic vein on the right forearm (35 males and 33 females). Other routes were the radial artery to cephalic vein on the left forearm (15 males and females) and the posterior tibial artery to the saphenous vein (seven males and six females on the left; one male and four females on the right)

Table 5 Distribution of patients operated on for external shunts according to the period of hemodialysis

Duration of hemodialysis	Number of patients	
	Male	Female
10 years<	3/3* (100%)	0/0 (0%)
5 ~ 10 years	13/52 (25%)	13/24 (54%)
4 ~ 5 years	4/21 (19%)	2/11 (18%)
3 ~ 4 years	7/28 (25%)	8/17 (47%)
2 ~ 3 years	10/31 (32%)	8/16 (50%)
1 ~ 2 years	5/37 (14%)	4/21 (19%)
1 year>	6/35 (17%)	4/20 (20%)

*Total number of patients with the same duration of hemodialysis.

(2) Arteriovenous fistulas (native vein)

Table 6 shows the number of arteriovenous (native vein) fistula operations on each patient according to the period of hemodialysis. Blood access troubles showed a strong tendency to increase as the period of hemodialysis became longer. One of the patients on hemodialysis for more than 10 years was operated on only once for an arteriovenous fistula while one patient was operated on five times and one 10 times.

Table 7 shows the number of well functioning initial arteriovenous fistulas in accordance with the period of hemodialysis. Nearly 50 percent of the first fistulas were functioning on December 31, 1981. One arteriovenous fistula was functioning well 10 years later. Arteriovenous (native vein) fistulas were mainly located in the radial artery to the cephalic vein (Brescia-Cimino) on the left forearm (Table 8). The majority of patients who were maintained on hemodialysis with an arteriovenous fistula available experienced no difficulties. We experienced 15 complications in fistula cases. Three were pseudoaneurysm formation, two were infections and ten were venous hypertension in the hand and vascular "steal" (sore thumb syndrome and steal syndrome).

Table 6 Number of arteriovenous fistula (native vein) operations on each patient.

Frequency of Operations	Number of patients													
	10 Y<*		5～10 Y		4～5 Y		3～4 Y		2～3 Y		1～2 Y		1 Y>	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
1	1	0	28	10	16	7	23	10	21	9	25	15	33	12
2	0	0	19	8	6	3	1	4	7	2	5	3	6	5
3	0	0	3	1	0	1	2	3	1	3	1	0	1	2
4	0	0	1	2	0	0	0	0	0	1	1	2	1	1
5	1	0	1	2	0	0	0	1	0	0	0	0	0	0
6	0	0	0	1	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	1	0	0	0	0	0	0	0	0	0	0	0	0	0

*Hemodialysis period groups (years)

Table 7 Functioning periods of arteriovenous fitsulas (first operation)

Functioning period	Number of patients													
	10 Y>*		5~10 Y		4~5 Y		3~4 Y		2~3 Y		1~2 Y		1 Y>	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
1 Week >	0	0	2	4	0	0	1	1	1	4	1	1	5	0
6 Month >	2	0	1	1	0	0	1	0	1	3	3	2	16	13
6~12 months	0	0	3	1	0	1	0	1	1	3	3	1	13	10
1~2 years	0	0	1	0	2	0	1	5	5	4	26	16	3	0
2~3 years	0	0	7	1	0	1	2	2	18	3	1	1	0	0
3~4 years	0	0	3	1	3	1	20	7	1	2	0	0	0	0
4~5 years	0	0	3	5	14	5	2	3	0	0	0	0	0	0
5 years <	1	0	32	10	2	2	0	0	0	0	0	0	0	0

*Hemodialysis period groups (years)

Table 8 Location of arteriovenous fistulas

	No. of patients	
	Male	Female
Radial artery — cephalic vein L	223*	120*
(Brescia — Cimino) R	48	49
Ulnar artery — basilic vein	1	1
Brachial artery — basilic vein	6	6
Other (Saphenous vein)	1	1

*including reoperated cases.

(3) Foreign body graft fistulas using expanded polytetrafluoroethylene (E-PTFE)

Five male and nine female patients were treated by maintenance hemodialysis using E-PTFE (Gore Tex) grafts. In all of these patients, the grafts were functioning well on December 31, 1981. One graft was functioning well 61 months later. E-PTFE grafts were located on the forearm (10 cases) and upper arm (eight cases). There was only one E-PTFE graft complication, i.e. marked edema after placement which required several weeks of elevation before resolution.

(4) Other blood access routes

One patient was treated by maintenance hemodialysis using femoral artery repositioning (subcutaneous femoral artery).

DISCUSSION

The initial evalution for renal failure patients is the optimal time to establish a tentative plan for immediate and long-term access requirements. Since the long-term prospects of the patient are largely dependent on the availability of blood access, it is essential to plan for this in the early stages of the disease.

There are many kinds of blood access (3): the external shunt, the arteriovenous (native vein primary fistula) fistula, reverse arteriovenous fistula, bovine xenograft, E-PTFE graft, vein autograft and femoral artery repositioning.

Use of the external AV shunt is rarely indicated in chronic renal failure. We attempted shuntless hemodialysis with direct femoral vein punctures (5) in cases of induction hemodialysis in chronic renal failure, shunt troubles in maintenance hemodialysis and emergency hemodialysis of acute renal failure, acute hepatic failure and drug intoxication.

The proportion of European patients with external shunts dropped from 10.4% in 1975 to 5.9% in 1978 (6) (7). No patient was dialysed through external shunts on December 31, 1981 among our patients.

The ideal management of vascular access for chronic renal failure is the placement of a forearm radiocephalic AV fistula.

The Cimino-Brescia type of internal fistula in Europe (1957) dominates regular dialysis, and 83.6% of all patients were recorded using this as the most frequent method of access (6). Fistula maturation often coincides with the initiation of dialysis.

The complication of venous hypertention in the hand has been seen only in internal side-to-side radiocephalic AV fistulas. Manifestations have included swollen, cyanotic hands with chronic pain which was exacerbated during hemodialysis. Stasis ulceration has been observed as a late manifestation. Simple and effective management involves ligation of the cephalic vein distal to the anastomosis. Other complications of internal fistulas are infections, aneurysm formation and thrombosis. We had 15 complications among the internal AV fistulas. Three were pseudoaneurysm formation, two were infection and ten were venous hypertension in the hand and vascular "steal".

Materials currently being used for secondary accesses (2) include bovine carotid or placental artery, expanded-polytetrafluorethylene (Gore Tex or Impra) and polyethylene terephthalates (Dacron). We experienced 14 hemodialysis cases using E-PTFE grafts and recognized that E-PTFE grafts tended to show greater resistance to infections and a lower rate of thrombosis. One thousand and fifty-six patients or 4.8% of the 22,041 European patients used vascular grafts as their most usual access in 1975 (6).

Internal vascular access (Cimino, grafts and PTFE combined) was used for 93.6% of European patients in 1978, compared to 88.4% in 1975 (6) (7).

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