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Original Article

Native Arteriovenous Fistula for Hemodialysis Access : Problems of Primary Failure

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Abstract

Introduction: **Native arteriovenous fistula is recommended as vascular access of choice for long term hemodialysis. However , the major problem of native arteriovenous fistula (AVF) is its primary failure.**

Objective: **To study the incidence of primary failure of native arteriovenous fistula and determine the factors associated with its primary failure.**

Materials and Methods: **All consecutive hemodialysis patients or patients with chronic kidney disease requiring a permanent vascular access from September 2003 to June 2011 were included in the study. All patients underwent native arteriovenous fistula as the first procedure. The relation between clinical characteristics with risk of primary failure was studied using logistic regression analysis.**

Results: The primary failure rate was 36.3% (66 of 182 patients). The factors related to an increased risk of primary failure were female gender (odds ratio(OR) : 1.468,95%, confidence interval (CI) : 0.799-2.698), age equal or more than 65 years (OR : 1.53, CI : 0.807-2.902), diabetes mellitus (OR : 1.437, CI : 0.756-2.733), AVF placement at wrist (compared with at elbow) (OR : 1.542, CI : 0.525-4.538), and AVF placement after hemodialysis (compared with placement before hemodialysis) (OR : 4.375, CI : 1.248-15.338). Timing of AVF placement (before or after hemodialysis) was statistically significant related to the primary failure rate (p-value < 0.21).

Conclusion: **Primary failure is a major problem for native arteriovenous fistula. Our study showed that AVF placement after establishment of hemodialysis was significant factor associated with the primary failure. The brachiocephalic AVF had lower primary failure rate than radiocephalic AVF and could be a good alternative choice in case of previous unmature radiocephalic AVF.**

Keywords: **arteriovenous fistula, hemodialysis vascular access**

Introduction

During the last decade, the number of patients with chronic kidney disease requiring chronic hemodialysis in Thailand has rapidly increased[1]. These patients need vascular access for hemodialysis. Native arteriovenous fistula (AVF) is recommended as vascular access of choice for chronic hemodialysis because of its long term good patency rate[2]. But the main problem of native arteriovenous fistula is its high primary failure rate[2]. The goal of this study was to evaluate the primary failure rate in a series of consecutive patients who underwent native

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arteriovenous fistula in our hospital and to determine the factors associated with their primary failures.

Materials and Methods

Patients

All consecutive hemodialysis patients or patients with chronic kidney disease requiring a permanent vascular access from September 2003 to June 2011 were included in the study. All patients were informed about the details of the procedure including the risks and benefits and have signed the informed consents before the operation.

Operations

All patients underwent native AVF as the first procedure. No preoperative vascular imaging was undertaken. The site of AVF placement was decided by only clinical examination. Whenever possible, the radiocephalic AVF was attempted first. If the forearm vessels were clinically inadequate for the creation of radiocephalic AVF or if a previous radiocephalic AVF failed to mature, brachiocephalic AVF just above the elbow was attempted later. A graft was constructed only if a brachiocephalic AVF had failed to mature.

Primary failure

Primary failure was defined as an AVF that was never usable for dialysis either to early thrombosis or due to lack of maturation[3]. This includes (1) inadequate maturation, (2) early thrombosis, (3) failure of first cannulation, and (4) other complications such as ischemia or infection. The definition of fistula maturation according to the National Kidney Foundation - Dialysis Outcomes Quality Initiative (NKF-DOQI) clinical practice guidelines for vascular access[2] comprise the rule of 6s. These are: A fistula, in general must be a minimum of 6 mm in diameter with discernable margins when a tourniquet is in place, less than 6 mm deep, have a blood flow greater than 600 ml/min, and should be evaluated for nonmaturation if, after 6 weeks from surgical creation, it does not meet these criteria.

Statistical Analyses

The relation between clinical characteristics with risk of primary failure was studied using logistic regression analysis. Results are presented as means ± SD and odds ratios (OR) with corresponding 95% confidence intervals (CI). Statistical significance was assumed when two-sided P-value was < 0.05. Analyses were carried out using Statistical Package for the Social Sciences (SPSS) for Windows (SPSS 13.0).

Result

From September 2003 to June 2011, a total of 209 cases of end staged renal disease underwent native arteriovenous fistula for chronic hemodialysis. Twenty-seven cases were excluded from the study because of death before fistula maturation in 18 patients, loss to follow-up before fistula maturation in 7, and change to chronic ambulatory peritoneal dialysis before fistula maturation in 2 patients. Of 182 patients in the study, 26 received 2 AVFs, and 3 received 3 AVFs. A total of 212 AVFs were created; 167 radio-cephalic fistula, 43 brachiocephalic fistula, and 2 forearm grafts. Mean age was 56.95±14.2 years (range, 16-86), and 56% were male. Clinical and demographic data of 182 patients are shown in Table 1.

Of 182 cases studied, radiocephalic AVFs were performed in 164 patients. Another 18 patients underwent brachiocephalic AVFs because forearm vessels were not suitable by clinical examination. Primary failure after first attempt occurred in 36.3 percent. Baseline characteristic of the patients with and without primary failure were shown in Table 2. On logistic regression analysis, factors related to an increased risk of primary failure were female gender (odds ratio (OR) : 1.468,95% confidence interval (CI) : 0.799-2.698), age equal or more than 65 years (OR : 1.53, CI : 0.807-2.902), diabetes mellitus (OR : 1.437, CI

Table 1 Clinical and demographic data of patients (n = 182)

Characteristics	Value
No. of AVF performed	212
Primary failure after first procedure (%)	36.3
Age (year; mean ± SD)	59.95+/-14.2
Age (year; range)	16 - 86
Age ≥ 65 years (%)	31.8
Female (%)	43.9
Diabetes (%)	31.3
AVF placement after hemodialysis (%)	87.3
AVF at wrist at first procedure (%)	90.1

: 0.756-2.733), AVF placement at wrist (compared with at elbow) (OR : 1.542, CI : 0.525-4.538), and AVF placement after hemodialysis (compared with placement before hemodialysis) (OR : 4.375, CI : 1.248-15.338) as shown in Table 3. Timing of AVF placement (before or after hemodialysis) was statistically significant related to the primary failure rate (p-value < 0.21)

Of 66 cases with primary failure, second procedure was performed in 29 patients with primary failure occurred in 7 patients. And of these 7 patients, third procedure was performed in 3 patients with good results. The detail of procedure was shown in Figure 1. Finally, of 182 patients studied, 138 patients (75.8 percent) had native AVF for hemodialysis access ; radiocephalic AVF in 105 patients and brachiocephalic AVF in 33 patients.

Table 2 Baseline characteristics of the patients with and without primary failure : result of a univariate analysis

Characteristics	Primary failure		P-value
	Yes	No	
No of patients	66	116	
Age (year; mean ± SD)	60.9±12.9	54.7±14.4	
Age ≥ 65 years (%)	37.9	28.4	0.189
Female (%)	50	40.5	0.215
Diabetes (%)	36.4	28.4	0.268
AVF placement after hemodialysis (%)	95.5	82.8	0.013*
AVF at wrist (%)	92.4	88.8	0.430

Table 3 Results from a logistic regression analysis of the relation of potential risk factors of primary failure

Characteristics	OR	95% CI	P-value
Female gender	1.468	0.799 - 2.698	0.216
Age => 65 years	1.53	0.807 - 2.902	0.191
Diabetes	1.437	0.756 - 2.733	0.269
AVF placement after hemodialysis	4.375	1.248 - 15.338	0.021*
AVF at wrist	1.542	0.525 - 4.538	0.433

Discussion

The current guidelines on hemodialysis recommend the native arteriovenous fistula as first choice vascular access[2]. A major problem to increasing the proportion of native AVF use is the high rate of primary failures because of early thrombosis or failure to mature occurring in 20 to 50 percent of native AVF[3]. The factors known to be responsible for primary failure are age, gender, diabetes, quality of vessel performed, site of fistula performed, timing of fistula performed, underlying extensive vascular disease, and experiences of surgeon[3,4,5,6,7,8].

Actually, the most important factor for fistula maturation is capability of both artery and vein to dilate sufficiently to have adequate flow rate. Fistula maturation depends on obtaining sufficient flow through the fistula to support hemodialysis and prevent thrombosis. This means that the artery and vein must

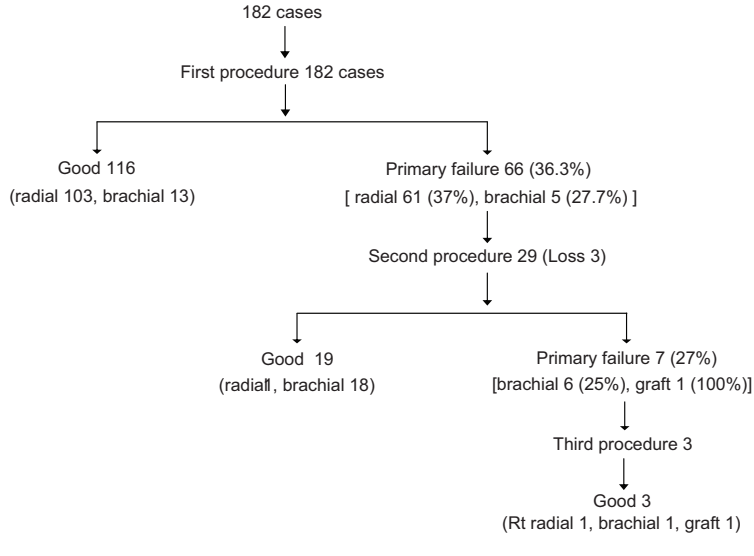

Figure 1 Diagram of native arteriovenous fistula performed with results at the first, second, and third attempts, Finally, of 182 patients studied, 138 patients (75 percent) had native AVF for hemodialysis access; radiocephalic AVF in 105 patients and brachiocephalic AVF in 33 patients.

dilate sufficiently[4].

Miller et al.[5] have shown that fistula adequacy for dialysis is worse in woman than in men, even when routine preoperative vascular mapping is used. Moreover, differences in vascular diameter between women and men cannot explain the inferior outcome of fistulas in women. Huijbregts et al.[6] have demonstrated that diabetes was significantly associated with primary failure. When evaluated by angiography, most insufficient fistulas have one or more antomic lesions that underlie the impaired maturation[7,9]. The most common finding is venous stenosis. More than half of the stenoses occur in the vein immediately downstream of the anastomosis (juxta-anastomotic stenosis) and frequently involve the anastomosis itself. Stenoses also occur further downstream in the proximal vein as well as less frequently in the central vein or feeding artery. However, in one prospective cotrolled study[7], 35% of fistulas that did not mature had no detectable lesion by angiography suggesting that failure of arterial and/or venous dilatation rather than stenosis was the predominant cause of failure in this subgroup.

Our results of primary failure rate were comparable with other studies[3]. Our results also demonstrated that female, old age, diabetes increase possibility of primary failure, although not statistically significant. One factor that increase possibility of primary failure significantly in our study was placement of AVF after establishment of hemodialysis. This may be explained by high incidence of distal venous stenosis from previous multiple venepuntures in these patients.

What can be done to improve fistula maturation? Preservation of veins, preoperative vascular mapping, and an experienced surgeon are important factors that are currently recommended[4]. Regarding preoperative vascular mapping, Huber et al.[10] showed that preoperative noninvasive and invasive imaging help to both identify and confirm the various possible fistula configurations so that it is possible to construct native AVF in almost all patients for permanent dialysis access. However, in the most recent paper, Peterson et al.[11] showed that disparities in fistula maturation could persist despite the use of routine preoperative vascular mapping.

It seems that primary failure of native AVF is sometimes unavoidable, so what should we do in this situation? There are many studies demonstrated that upper arm native AVF has lower rate of primary failure than radiocephalic AVF[12,13,14]. Our result also showed that brachiocephalic AVF had lower primary failure rate and was a good alternative choice in case of previous unmature radiocephalic AVF. Some authors suggest graft rather than upper arm AVF[15]. Grafts may play a role in high-risk patients (especially those with previous AVF failures) or those who are referred late, with the dual benefit of maturing vessels for future AVF and obviating the need for central venous catheter and their associated adverse consequences[16]. Recognition of these factors has led the K/DOQI VA 2006 update to suggest that grafts can be used as a "planned bridge" to an AVF and failing forearm grafts can be converted to upper arm AVF[2].

Conclusion

The primary failure rate of native AVF in our studies was 36.3%, which was comparable with other studies. The factors associated with primary failure were female gender, old age, diabetes, and AVF placement after establishment of hemodialysis. However, the brachiocephalic AVF had lower primary failure rate than radiocephalic AVF and could be a good alternative choice in case of previous unmature radiocephalic AVF.

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