

» **Original Article** «

Outcomes of Endovascular Intervention for Salvage of Failing Hemodialysis Access

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Objective: To investigate the effectiveness of endovascular balloon angioplasty to preserve the patency of failing hemodialysis arteriovenous fistulas (AVF) and prosthetic arteriovenous grafts (AVG).

Methods: Patients on hemodialysis who received endovascular intervention for access problems were retrospectively analyzed. Fistulography was performed on patients who were suspected to have access stenosis and balloon angioplasty performed in the same setting if a stenosis of $\geq 50\%$ is detected. Patients were followed up for post-operative complications and access restenosis or failure.

Results: 42 hemodialysis patients with 44 access sites (29 AVFs, 15 AVGs) required endovascular balloon angioplasty. There were no perioperative complications. Technical success rate was 100%. Median time from initial access creation to first balloon angioplasty was 13 months (2–146 months) for AVFs and 8 months (2–71 months) for AVGs. 19 of 44 patients subsequently developed restenosis. Median time for restenosis or access failure was 11 months (1–18 months) for AVFs and 5 months (1–10 months) for AVGs. Kaplan-Meier analysis for access patency after endovascular intervention showed 72% patency at 6 months and 32% at 12 months.

Conclusions: Endovascular balloon angioplasty is effective in restoring patency of failing hemodialysis accesses. Recurrence is common, and repeat interventions are required.

Key words: angioplasty, arteriovenous fistula, arteriovenous graft, renal failure, hemodialysis

INTRODUCTION

Autogenous arteriovenous fistulas (AVF) and prosthetic arteriovenous grafts (AVG) are necessary for chronic end-stage renal failure patients on hemodialysis. AVFs are the preferred initial hemodialysis access due to their longer patency than AVGs.¹⁾ AVGs, however, remain

clinically important in patients whom AVFs are not feasible, and possibly in special populations such as the elderly.^{2–4)}

Hemodialysis accesses are prone to failure due to thrombosis, usually concomitant with stenosis over the anastomosis or outflow vein. Access thrombosis frequently requires semi-emergent salvage intervention, but outcomes are generally unfavorable. Patients eventually may require multiple salvage procedures to restore functionality or creation of a new access. Some patients require placement of central venous catheters in the interim whilst the hemodialysis access becomes fully functional. Alternatively, to prevent access failure, clinicians can monitor the performance of these accesses and prophylactically provide interventions to rectify the hemodynamic problems and prolong their patency.⁵⁾

Our service currently provides endovascular interventions to haemodialysis patients with failing access. This

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Table 1 Patient demographics

	Total
Age (Mean \pm SD)	59.8 \pm 11.3
Sex: Male (%)	24 (57.1%)
Sex: Female (%)	18 (42.9%)
Diabetes mellitus	32 (73%)
Hypertension	37 (84%)
Ischaemic heart disease	18 (41%)
Hyperlipidaemia	25 (57%)
Peripheral vascular disease	9 (21%)
Stroke	6 (14%)
Smokers, active	6 (14%)

study aims to review the effectiveness of endovascular intervention for preservation of failing accesses.

PATIENTS AND METHODS

This study is approved by the institutional review board at our hospital. From August 2008 to March 2010, hemodialysis patients who received endovascular treatment for their dialysis access problem in the Vascular Surgery division of National University Hospital, Singapore, were retrospectively analyzed. The feature of failing AVFs or AVGs included one or more of the following: 1) Reduced thrill of vascular access assessed by clinical palpation by a vascular surgeon (P Ho), 2) Documented decreased dialysis flow rate defined by KDOQI guidelines⁶⁾ (access flow less than 600 ml/min, or less than 1000 ml/min with a more than 25% decrease over a four month period, 3) Documented increased venous pressure during dialysis as defined by KDOQI guidelines⁶⁾ (venous pressure of more than 150 mmHg or a trend of persistent increasing pressure over time) 4) Stenosis detected by duplex ultrasound, 5) Non-maturation of an AVF six weeks post-creation. Patient demographics and co-morbidities were documented.

Fistulograms were offered to all patients with one or more of the above-mentioned features of vascular access failure. The degree of stenosis in the peri-anastomotic region, fistula/graft, outflow vein and central veins were assessed during fistulography. Endovascular intervention in the form of balloon angioplasty was performed in the same setting if a stenosis of 50% or more of the vessel diameter is detected on angiography, using either a simple Wanda balloon (Boston Scientific, Natick, MA, USA) or a Peripheral cutting balloon (Boston Scientific, Natick, MA, USA). Cutting balloons were utilized for high grade

Table 2 Frequency of indication for fistulogram

Evidence of failing dialysis access	Number of cases (%)
Decreased dialysis flow rates	26 (59.1%)
Stenosis on duplex ultrasound	7 (15.9%)
Lack of fistula maturation	4 (9.1%)
Increased venous pressures	2 (4.5%)
Suspected thrombosis	2 (4.5%)
Difficulty in dialysis cannulation	2 (4.6%)
Poor thrill on clinical examination	1 (2.3%)

stenosis ($\geq 90\%$ stenosis) or total occlusion on fistulography, or when a simple balloon did not result in satisfactory restoration of access patency (re-stenosis $>50\%$). Completion fistulogram was performed immediately after angioplasty to determine success of the procedure. All patients were observed in the day surgery ward for two to three hours and discharged if no acute complications (bleeding or thrombosis) were detected. AVFs and AVGs, which were functional for dialysis pre-intervention, were used for dialysis the day after angioplasty.

Data are given as percentages and medians (range). Patency rates of hemodialysis access after initial salvage angioplasty were calculated according to the Kaplan-Meier method. Statistical analyses were performed using PASW Statistics 18 (IBM SPSS, Chicago, IL, USA). The fistulograms of the vascular accesses that require secondary intervention were reviewed to compare the sites of obstruction in the initial and subsequent intervention.

RESULTS

During the study period, 42 patients with a total of 44 hemodialysis accesses had stenosis confirmed by fistulogram and subsequently underwent balloon angioplasty for rectification of hemodynamic obstruction. 24 (57.1%) patients were male and 18 (42.9%) were female, with a mean age of 59.8 \pm 11.3 (Range, 28–82). Medical co-morbidities were common among the studied population: 32 patients had diabetes mellitus (73%), 37 had hypertension (84%), 18 had ischaemic heart disease (41%), 25 had hyperlipidemia (57%), 9 had peripheral vascular disease (21%), and 6 had a history of stroke (14%). 6 of the patients were active smokers (14%) (**Table 1**).

Of the 44 hemodialysis accesses, 29 (65.9%) were AVFs, and 15 (34.1%) were AVGs. Frequencies of the

Table 3 Median time from access creation to first endovascular intervention

	Median (months)	Range (min-max)
AVF (n = 29)	13	2–146
AVG (n = 15)	8	2–71
Total (n = 44)	11	2–146

Table 4 Median time from first endovascular intervention to subsequent access failure

	Median (months)	Range (min-max)
AVF (n = 10)	11	1–18
AVG (n = 9)	5	1–10
Total (n = 19)	8	1–18

chief indication for fistulogram in the 44 accesses studied are listed in **Table 2**. As shown, the majority of patients were noted to have decreased access flow rates as measured during dialysis. The median time from access creation to the time of intervention was 13 months (Range, 2–146 months) for AVFs, and 8 months (Range, 2–71 months) for AVGs, yielding an average, median interval of 11 months (Range, 2–146) for all 44 accesses (**Table 3**).

The procedure success rate was 100%. No complications, notably bleeding and thrombosis, were detected after the interventions. Of the four non-mature AVFs, three eventually matured after angioplasty and was able to be used for dialysis. The remaining one AVF failed to mature, and this patient required the creation of a new vascular access. All other salvaged accesses were functional for dialysis immediately post-intervention.

After initial angioplasty, patients were followed up for a median of 5 months (Range, 1–18 months). 19 of the 44 (43.2%, 10 AVFs and 9 AVGs) accesses initially revised eventually failed again. There was no significant difference between the proportion of AVFs and AVGs that required a secondary procedure (34.5% AVFs, 60.0% AVGs, $p = 0.097$). On these 19 accesses, 11 accesses (57.9%) required a second angioplasty to restore patency, 5 (26.3%) thrombosed, and required the creation of new hemodialysis access, 1 (5.3%) required a jump graft, 1 (5.3%) required surgical revision, and 1 (5.3%) was converted to peritoneal dialysis after the access thrombosed.

Analysis of fistulographs of the 11 accesses that required a second angioplasty showed that stenosis recurred at the same site in 7 (63.6%) accesses, occurred in both the old and a new site in 2 (18.2%) accesses, extended contiguously in 1 (9.1%) access, and receded

from two sites to one in 1 (9.1%) access.

The median time from initial salvage angioplasty to re-intervention was 11 months (Range, 1–18 months) for AVFs and 5 months (Range, 1–10 months) for AVGs, yielding an average, median interval of 8 months (Range, 1–18 months) (**Table 4**). During the study period, four patients died from causes unrelated to hemodialysis access procedure (two from acute myocardial infarction, one from septic shock and one from a bleeding duodenal ulcer). Kaplan-Meier curves for hemodialysis accesses after initial balloon angioplasty showed a patency rate of 72% at 6 months and 32% at 12 months (**Fig. 1**).

DISCUSSION

Hemodialysis accesses in the form of AVFs or AVGs are integral to sustaining life in patients with established end-stage kidney disease. However, AVFs, and especially AVGs, are prone to stenosis and thrombosis which may preclude hemodialysis. Abandonment of a primary access frequently necessitates the creation of secondary and even tertiary accesses. The need for additional interventions⁷⁾ in a group of patients already immunocompromised by renal disease results in increased hospital stays, increased economic costs,⁸⁾ and increased morbidity and mortality.¹⁾

Thus, it is important for nephrologists and vascular surgeons to adopt strategies that will minimize morbidity and maximize quality of life when dealing with patients on hemodialysis. In 2006, the Dialysis Outcomes Quality Initiative (DOQI) published by the US National Kidney Foundation¹ strongly recommended the placement of AVFs as a primary access for hemodialysis. This was based on research showing that patients with AVFs had a

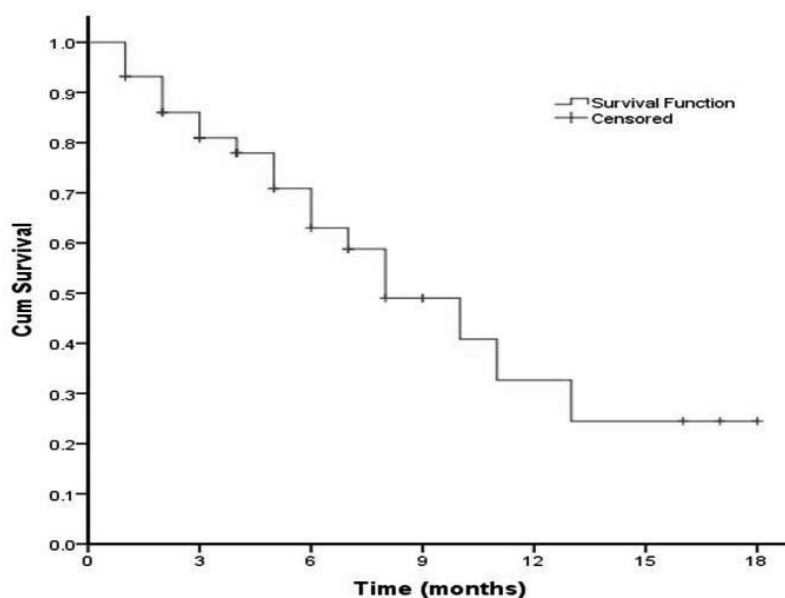


Fig. 1 Kaplan-Meier analysis for dialysis access patency after first endovascular intervention.

better overall quality of life than those with AVGs.⁹⁾ Indeed, most studies have subsequently showed that AVFs are beneficial compared to AVGs, with AVFs having greater primary patencies compared to AVGs.¹⁰⁻¹²⁾ This finding correlates with the results of the present study, where the median time needed from access creation to initial intervention was 13 months for AVFs, and 8 months for AVGs. Moreover, after the initial intervention, the time to develop restenosis or thrombosis was shorter in AVGs compared to AVFs. The shorter time taken for AVGs to develop stenosis and subsequent restenosis post-intervention indicates that patients with AVGs require more frequent interventions to maintain graft patency. AVGs, however, are nonetheless required in patients with inadequate upper arm veins and in those who have exhausted their autogenous venous capital. Some studies have shown that elderly³⁾ and diabetic patients²⁾ with AVGs have better access patency rates when compared to similar patients with AVFs, indicating that patient co-morbidities and demographics may play an important role in determining the best hemodialysis access type.

In this study, decreased flow rates and increased venous pressures measured during dialysis were the chief reasons suggesting that a patient's hemodialysis access was failing. This suggests that routine monitoring of access performance during dialysis is useful in picking up early access failure for salvage intervention. Some cli-

nicians advocate a regular surveillance program involving dialysis flow parameters^{1, 13)} or duplex ultrasound imaging,¹⁴⁾ in addition to standard of care clinical monitoring to detect and prophylactically intervene with failing hemodialysis accesses. Research has shown that regular surveillance may lead to improved quality of life for dialysis patients,¹⁵⁾ possibly from a reduction in the quantity of time spent in hospitals due to complications of access failure.¹⁶⁾ This benefit, however, has to be viewed in the context of unnecessarily exposing patients to increased numbers of salvage interventions as a consequence of routine surveillance.^{17, 18)} Importantly, there is substantial evidence that regular surveillance of AVGs may not decrease the risk of graft thrombosis,¹⁹⁾ nor prolong the time to graft abandonment.^{18, 20)} On the other hand, regular surveillance of AVFs does decrease the risk of access thrombosis,²¹⁾ but its effect on improving AVF patency is uncertain, with clinical trials producing conflicting results.^{21, 22)} Surveillance protocols using ultrasonography in previous studies have mostly monitored accesses every 3–4 monthly.^{18, 23, 24)} Given that the median time to initial and secondary intervention in this study for AVFs is 13 months and 11 months respectively, it is likely that a six-month surveillance programme will detect significant stenosis amenable to prophylactic intervention. A prospective comparative study investigating the patency rates of hemodynamic accesses and cost effectiveness under different surveillance intervals will

be needed to determine what the optimal surveillance interval should be. This longer interval between surveillance points may have the advantages of decreasing healthcare resources and costs required, also prevent patients from undergoing multiple unnecessarily procedures.

Percutaneous transluminal angioplasty (PTA) is the mainstay of treatment in stenosed hemodialysis access. With current techniques, PTA is a safe and useful intervention to restore access patency and preserve venous capital for future AVF or AVG creation.²⁵⁾ PTA restores the luminal diameter of venous fistula by stretching and dissection of the vessel wall. This induces vascular damage and may cause subsequent restenosis.²⁶⁾ Whether the mechanism of venous restenosis is similar to arterial restenosis is uncertain. However, in our experience, venous restenosis seems to recur more frequently than that of its arterial counterpart. Cutting balloon angioplasty reduces the amount of arterial wall damage by inducing a controlled fracture of atherosclerotic plaque. It is currently uncertain if cutting balloon angioplasty will reduce the recurrence rate of venous stenosis as compared to conventional balloon angioplasty. A recent study by Kariya et al.²⁷⁾ showed no significant differences between these two techniques. Stenting of access stenosis is usually regarded as a second line option to balloon angioplasty and is usually performed only if balloon angioplasty is unsuccessful or with dissection. However, there is some evidence to suggest that stenting alone can improve patency outcomes in both AVFs and AVGs.²⁸⁾ A recent study^{29, 30)} has also shown that combined balloon angioplasty and stent-grafting confers an improved patency rate in AVGs with venous anastomotic stenosis over balloon angioplasty alone. It is not known if similar findings extend to AVFs.

CONCLUSION

Endovascular intervention in the form of balloon angioplasty is a safe and effective treatment for failing AVFs and AVGs. Re-stenosis is common and often requires further intervention in the form of repeat angioplasty.

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