Predicting loss of patency after forearm loop arteriovenous graft

Kotaro Suemitsu, MD,[a] Osamu Iida, MD,[b] Tatsuya Shiraki, MD,[b] Satoko Suemitsu, MD,[c] Masaaki Murakami, MD,[d] Masahito Miyamoto, MD, PhD,[c] Masaaki Izumi, MD, PhD,[a] and **Takeshi Nakanishi, MD, PhD,[f]** *Amagasaki, Itami, Shizuoka, Yokohama, and Nishinomiya, Japan*

Objective: **Although arteriovenous grafts (AVGs) for dialysis access have been applied to patients who were poor candidates for an arteriovenous fistula, durability after AVGs has been clinically suboptimal. This retrospective study investigated whether forearm AVGs based on radial artery inflow would have superior patency to those with brachial artery inflow and evaluated the operative predictors for loss of patency after AVG.**

Methods: **This multicenter retrospective study included 156 upper limbs in 150 consecutive patients (50% male; age, 70.5 ± 12.8 years) who underwent forearm loop AVG formation from January 2010 to October 2013. The outcome measures were the primary and secondary functional graft patency rates and factors related to primary patency. Primary and secondary patency of AVGs was evaluated by Kaplan-Meier analysis, and predictors for loss of primary patency of AVGs were determined using a Cox proportional hazards model.**

Results: **The median observation period was 10 months (interquartile range, 6-18 months). The 1-year primary patency rate was 32.4%, and the secondary patency rate was 83.4%. Use of the radial artery as the inflow arteriovenous anastomosis (hazard ratio, 0.56; 95% confidence interval, 0.30-0.99) was independently associated as an operative predictor for primary patency after AVG. The primary patency rate was significantly different between radial artery inflow and brachial artery inflow at 1 year (53.8% vs 24.4%; $P = .032$).**

Conclusions: **Radial artery selection as inflow artery was independently associated with primary patency after AVG. (J Vasc Surg 2016;64:395-401.)**

At the end of 2010, the number of patients with end-stage renal disease on regular dialysis reached 2,620,000 worldwide, and the number is estimated to increase to 5,439,000 in 2030.[1] Patients on hemodialysis are now increasing at an annual rate of 7%,[2] and this trend is considered likely to accelerate in the future due to the increase of patients with end-stage renal disease and diabetes mellitus, causing concern about higher medical costs.

The standard operation for vascular access in patients who require regular dialysis is the arteriovenous fistula (AVF), whereas an arteriovenous graft (AVG) is used when an AVF is difficult to create. However, the long-term patency rate after AVG construction is extremely dire, being 23% at 1 year and a mere 4% after 2 years.[3] To maintain a functioning AVG by durable patency, the efficacy of a cuffed graft,[4-7] heparin-bonded hemodialysis expanded polytetrafluoroethylene (ePTFE) graft,[8,9] and synthetic polyurethane graft[10] has been reported, and combined therapy with aspirin and dipyridamole has also been reported to improve the durability.[11]

In general, an AVF or AVG is created in the most distal vessel possible to allow reconstruction at a more proximal site if malfunction occurs. However, the standard methods for acquiring optimal durability after AVG construction has not been well examined, and low patency rates are still a clinical issue. This retrospective study investigated whether forearm AVGs based on radial artery inflow would have superior patency compared to those with brachial artery inflow. In the present study, we investigated the patency rate of forearm loop AVGs and the factors related to patency.

METHODS

Patients. A retrospective study was conducted of 156 forearm loop AVGs that were created in 150 consecutive patients between January 2010 and October 2013 at three institutions (Kinki Central Hospital, Yokohama Daiichi Hospital, and Shizuoka General Hospital). All participants gave informed consent. This study was performed according to the Declaration of Helsinki and was approved by the Ethics Committee of each institution.

AVG procedure. The patient's general condition and comorbidities were both considered when deciding the indications for strategy of vascular access based on consensus between nephrologists and dialysis specialists. A forearm loop AVG was selected for patients whose superficial veins were damaged or difficult to puncture as

From the Division of Kidney and Dialysis, Department of Internal Medicine, Kansai Rosai Hospital,[a] and the Cardiovascular Center, Kansai Rosai Hospital,[b] Amagasaki; the Department of Nephrology, Kinki Central Hospital, Itami[c]; the Department of Nephrology, Shizuoka General Hospital, Shizuoka[d]; the Vascular Access Center, Yokohama Daiichi Hospital, Yokohama[e]; and the Division of Kidney and Dialysis, Department of Internal Medicine, Hyogo College of Medicine, Nishinomiya.[f]

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Correspondence: Kotaro Suemitsu, MD, Kansai Rosai Hospital, 3-1-69 Inabasou, Amagasaki, Hyogo 660-8511, Japan (e-mail: suemitsu0711@gmail.com).

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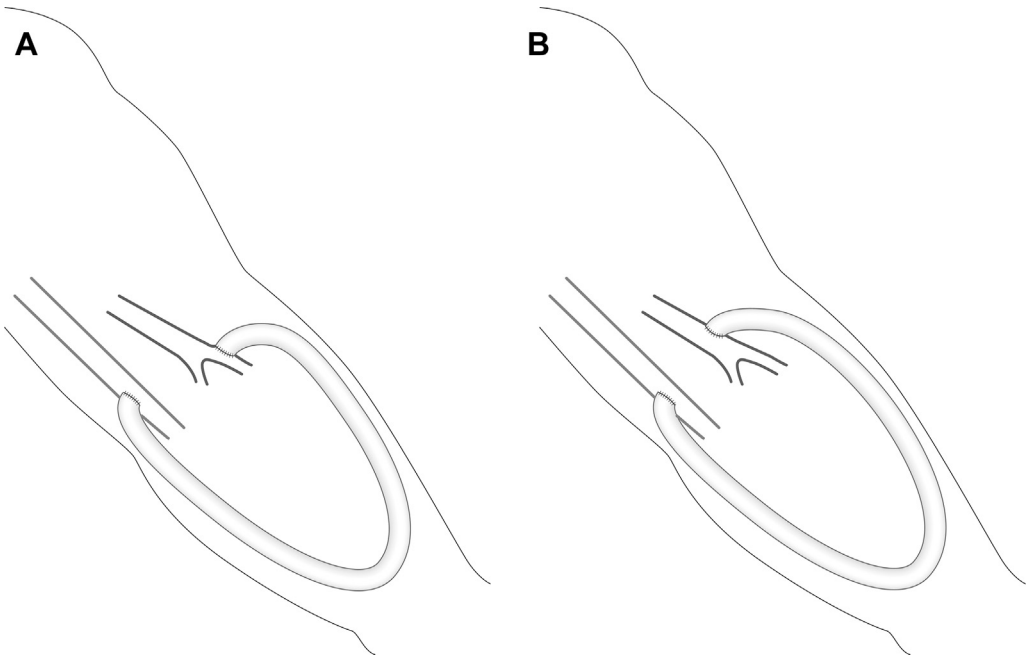

Fig 1. The radial artery was selected as the inflow artery in patients with (1) risk of steal syndrome and (2) a ≥1.5-mm-diameter proximal radial artery. The risk of steal syndrome was estimated if radial artery or ulnar artery was severe stenosis or occlusion before arteriovenous graft (AVG). **A,** If the proximal radial artery was <1.5 mm, **(B)** the brachial artery was selected.

assessed by duplex ultrasound imaging. The loop AVG was created under local anesthesia, with or without brachial plexus block, based on each condition. The radial artery was generally selected as the inflow artery in patients with (1) risk of steal syndrome and (2) with a ≥1.5-mm-diameter proximal radial artery (Fig 1, *A*). The risk of steal syndrome was routinely estimated by duplex ultrasound imaging if severe stenosis (peak systolic velocity ratio >3 or peak systolic velocity >3 m/s) was present in the radial artery or ulnar artery, or both, or there was occlusion before the AVG. In others, the brachial artery was selected (Fig 1, *B*). An end-to-side arterial anastomosis was generally performed. Selection of the outflow vein was left to the doctor's discretion. The end-to-side anastomosis was usually done for the graft, although an end-to-end anastomosis was selected if there was no size mismatch between vein and graft. The surgeon chose the type of graft and its size.

Outcome measures and variables. The outcome measures of this study were the rates of primary and secondary functional graft patency along with factors related to primary patency. Data collected from the hospital medical records included the age, sex, duration of dialysis, primary cause of renal failure, and prior AVF or AVG surgery. The operative records were also reviewed to determine the inflow artery, outflow vein, graft size, graft type, and anastomotic technique. Postoperative surveillance was conducted every 3 months by duplex ultrasound imaging.

Definitions. Flow volume was measured by duplex ultrasound imaging. Primary patency was defined as a patient without symptoms or signs caused by graft occlusion, a graft with normal function, and no need for repeat intervention. The duration of secondary patency was the period during which graft function was maintained by an intervention or other treatment. Procedural success was defined as a construction without any occlusion ≤72 hours after surgical AVG. Intervention was indicated for AVG occlusion, increased venous pressure, recirculation where effective hemodialysis was impossible, or graft flow <400 mL/min on duplex ultrasound imaging when hemodialysis was possible. Dialysis duration was defined as from initiation of dialysis to surgical AVG, including any period of peritoneal dialysis, hemodialysis, and renal transplantation.

Statistical analysis. Data are reported as the mean ± standard deviation or median (interquartile range). Normality of data was verified by Kolmogorov-Smirnov test. Comparisons between groups were conducted using the unpaired *t*-test for continuous variables and the χ^2 test for binary variables. Kaplan-Meier analysis was used to calculate patency rates, and the significance of differences between curves was assessed with the log-rank test. Univariate and multivariate analysis was performed with the Cox proportional hazards model to identify factors related to primary patency. A *P* value of <.05 was considered significant. SPSS 21.0J software (IBM Corp, Armonk, NY) was used for these analyses.

RESULTS

Patient characteristics. We analyzed 156 forearm loop grafts in 150 patients (50% male). Baseline characteristics are