Outcomes of Autogenous Snuffbox Radiocephalic Arteriovenous Fistula-First Strategy for Hemodialysis Access

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ABSTRACT

Objective: An autogenous arteriovenous fistula (AVF) has been recommended as the first-line hemodialysis access option. A distal radiocephalic (snuffbox) arteriovenous fistula (SBAVF), the most distally located AVF, provides an extended vascular access area, allows future AVF correction in the proximal part, and offers relatively easy surgical access. This study aimed to evaluate the outcomes of patients who had SBAVFs as their first option for dialysis access.
Methods: The medical-record electronic database of Siriraj Hospital, Bangkok, Thailand, was retrospectively reviewed to evaluate the outcomes of patients receiving SBAVFs July 2013-December 2016 with over 12 months of follow-up.
Results: Of 39 patients, SBAVFs were successfully created in 33 patients (84.6%). Early thrombosis was observed in 1 patient. Steal syndrome, distal thrombosis, and complications of high-venous flow were not detected. The primary, primary-assisted, and secondary patency rates at 12 months were 60.6%, 81.8%, and 100%, respectively, and at 24 months were 51.5%, 72.7%, and 97.0%, respectively. Diabetes showed a significant correlation with failed AVF maturation, and venous diameters under 2.5 mm significantly reduced the 1-year primary patency. SBAVFs were successfully created in 9/12 patients who had a borderline venous size (< 2.5 mm), resulting in the AVF creation rate improving from 66.7% to 89.7%.
Conclusion: Autogenous distal radiocephalic (snuffbox) arteriovenous fistula is a feasible first-line option, especially for young, non-diabetic patients who are not in urgent need of hemodialysis. This strategy could also enhance the possibility of autogenous AVF creation in patients with a borderline venous size.

Keywords: Arteriovenous fistula; snuffbox arteriovenous fistula; hemodialysis; vascular access for hemodialysis; AVF (Siriraj Med J 2019; 71: 499-505)

INTRODUCTION

According to a report on renal replacement therapy in Thailand, the number of patients requiring treatment for renal replacement therapy has been increasing. There were twice as many patients in 2015 as in 2010, and hemodialysis was implemented in the majority of cases (65.2%).[1] As to the hemodialysis modalities, an autogenous arteriovenous fistula (AVF) has been recommended as the first-line approach over arteriovenous graft (AVG) and central venous catheter-based hemodialysis (CVC) by both the National Kidney Foundation Kidney Disease Outcomes Quality Initiative (NKF-KDOQI) guideline recommendations of 2006[2] and the Society for Vascular Surgery clinical practice guidelines of 2008.[3] This was because of AVF's comparatively lower complication rates; superior long-term functions; and favorable survival

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outcomes[4-5], evidenced by fewer high-flow or ischemic complications (especially in the distal-location). It also offers the possibility of a new, proximal, AVF creation.

Distal radiocephalic arteriovenous fistula for hemodialysis at the anatomical snuffbox (SBAVF) is considered the most distally located AVF. It is created by an anastomosis between the dorsal branch of the radial artery in the anatomical snuffbox region and the cephalic vein at the base of the thumb. Because the two vessels lie in parallel and are in close proximity, SBAVF creation provides a favorable angle and allows for ease of surgical access. Further advantages of SBAVF are its wider vascular access area and its potential for the later creation of a wrist radiocephalic AVF.[6–7] Despite the advantages of an AVF in the wrist or snuffbox region, many patients are not feasible candidates for SBAVF creation. This is mainly because of the relatively small vessel size in this area, which is challenging for a distal AVF-first strategy. However, several authors have reported favorable outcomes for SBAVFs in patients with borderline vessel size.[7-9]

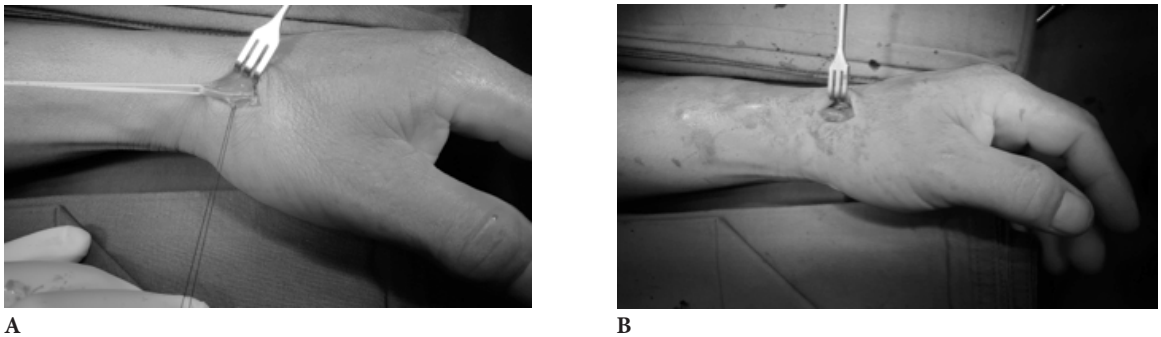
The aim of this study was to evaluate the outcomes of SBAVFs, including factors affecting maturation and patency in patients with borderline vessel size, in order to enhance the creation of an autogenous arteriovenous fistula-first protocol for patients requiring long-term hemodialysis.

MATERIALS AND METHODS

The medical-record electronic database of Siriraj Hospital was retrospectively reviewed to identify all patients who had undergone an autogenous distal radiocephalic (snuffbox) arterio-venous fistula creation for hemodialysis between July 2013 and December 2016. Excluded were patients who had incomplete data, were unable to attend follow-ups, or had an abandoned arterio-venous fistula within 12 months of the fistula creation. Kidney transplantations, elective changes to different renal replacement therapies, or death were considered to be censored events. Demographic data (such as age, gender, and co-morbidities like diabetes mellitus and coronary artery disease), factors related to the hemodialysis management (including the serum creatinine level), and the status of the hemodialysis were recorded. Patient management and follow-ups were conducted as per the Division of Vascular Surgery's protocols, which encompassed a preoperative assessment with duplex ultrasonography, the operative procedures, and the postoperative follow-ups (comprising an initial 1- to 2-week postoperative period for wound care and subsequent 1- to 3-monthly assessments of the fistula maturation and complications). Preoperative duplex ultrasonography was used to assess both the arterial and venous size (using the tourniquet technique), continuity of the vessel, and potential sites for a proximal AVF and AVG. Patients who had a history of coronary artery disease were evaluated by cardiologists before undergoing the AVF procedure.

Surgical procedures: All arteriovenous fistulas were created through a 2-cm longitudinal incision under local, regional, or general anesthesia by vascular surgeons. Radiocephalic fistulas were accomplished in a side-to-end fashion, and 6-8 mm radial artery arteriotomies were anastomosed with cephalic veins using polypropylene no. 6/0 or 7/0, according to the vessel size (Fig 1).

Outcome measures: The primary outcome was fistula maturation, which was determined by vascular surgeons based on physical examinations and evidence of adequate venous flow in duplex ultrasonography (Fig 2). Primary maturation was defined as an arteriovenous fistula maturing without any additional intervention. Assisted primary maturation was defined as an arteriovenous fistula needing additional surgical or endovascular intervention to mature. Secondary (cumulative) maturation was defined as an arteriovenous fistula maturing regardless of a prior thrombosis or the need for a surgical or endovascular intervention.



A B

Fig 1. The photographs of (A) incision and cephalic vein dissection of left distal radio-cephalic arteriovenous fistula and (B) completion of left snuffbox radio-cephalic anastomosis.

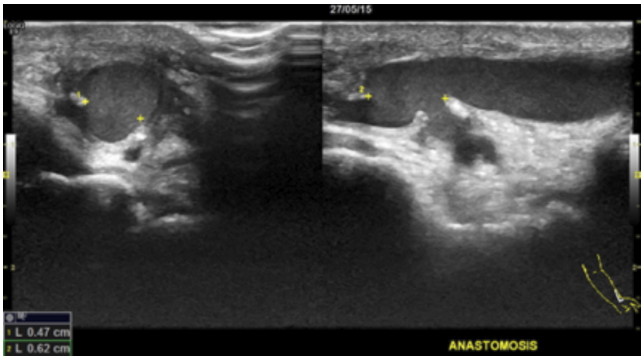


Fig 2. Postoperative assessment of anastomosis size.

The secondary outcomes were the time when the fistulas were accessed and the patency of the arteriovenous fistulas. In detail, primary patency was defined as the time to achieve a functioning arteriovenous fistula without any additional intervention. Primary-assisted patency was defined as the time to achieve an uninterrupted functioning arteriovenous in the case of those fistulas needing a surgical or endovascular intervention to maintain patency. Secondary (cumulative) patency was defined as the time to achieve a functioning arteriovenous fistula regardless of interventions or thrombosis. This study was approved by the Ethics Committee of the Institutional Review Board of the Faculty of Medicine Siriraj Hospital, Mahidol University, Thailand (Si 783/2559).

Statistical analysis: All data were analyzed using IBM SPSS Statistics for Windows, version 24 (IBM Corp., Armonk, NY, USA). The analyses comprised descriptive statistics, outcomes analysis by Chi-square, logistic regression, and survival analysis by Kaplan–Meier survival plots for patency rates.

A total of 39 distal radiocephalic arteriovenous fistula creations were included in this study. The patients' median age was 58 years (range, 25–80 years). Twenty-five patients (64.1%) were male; 21 (53.8%) had diabetes mellitus; 8 (20.5%) had received a coronary artery intervention; while one (2.6%) had lower extremity arterial occlusive disease (Table 1). Eighteen patients (46.2%) were receiving catheter-based hemodialysis, and of those without hemodialysis, the mean serum creatinine level was 5.84 ± 1.97 mg/dL.

The preoperative vascular assessment found that the mean radial artery diameter was 2.41 mm (standard deviation, ± 0.46 mm) and the mean cephalic vein diameter was 2.29 mm (standard deviation, ± 0.50 mm).

Fistula creations were performed under local, regional, and general anesthesia on 32 (82.0%), 4 (10.3%), and 3 (7.7%) patients, respectively. Anastomoses were performed by running polypropylene number 7/0 in 34 patients (87%) and number 6/0 in 5 patients (13%). There were no reports of wound complications (infections and hematomas), steal syndrome, or distal ischemia. One patient developed thrombosis within the first 24 hours, while another two complained of reversible numbness at the left thumbs, both of which were completely recovered within 3 and 6 months post operation.

TABLE 1. Demographic data and chronic kidney disease parameters.

Clinical variable	No. of patients (%) Total n = 39
Age (years)	
Median	58
Range	25-80
< 50 years	14 (35.9%)
50-70 years	16 (41.0%)
> 70 years	9 (23.1%)
Gender	
Male	25 (64.1%)
Female	14 (35.9%)
Comorbidities	
Diabetes mellitus	21 (53.8%)
Coronary artery disease	8 (20.5%)
Lower extremity arterial occlusive disease	1 (2.6%)

The primary, primary-assisted, and secondary (cumulative) maturation responses were 59%, 64.1%, and 84.6%, respectively (Table 2). All 10 patients who failed to achieve primary maturation required transposition to wrist radiocephalic fistula creations. The maturation times ranged from 2 to 12 months (median, 3 months). Diabetic patients had a significant correlation with maturation failure. Male patients and patients younger than 50 years of age demonstrated a tendency to higher maturation rates after correlations with diabetes were adjusted. On the other hand, venous size and a history of coronary artery disease did not display significant correlations with maturation rates.

The follow-up periods ranged from 12 to 50 months (median, 29 months). The patency results are presented as Kaplan–Meier Plots in Fig 2. It was found that the primary, primary-assisted, and secondary patency rates at 12 months were 60.6%, 81.8%, and 100%, respectively, and at 24 months were 51.5%, 72.7%, 97.0%, respectively. A Cox regression analysis evaluating the clinical factors (age group, gender, diabetes, and vein size) and the 1-year primary patency rates revealed significantly lower primary patency rates in patients whose cephalic venous size was less than 2.5 mm.

DISCUSSION

A distal radiocephalic arteriovenous fistula at the anatomical snuffbox (SBAVF) has been recommended as the first-line approach over other types of AVF, including wrist AVF, by several authors.[6–10] However, its popularity and the number of reported cases have been low relative to the other AVF types. This could be the result of limited vessel-size feasibility and varied outcomes. Wolowczyk et al. reported that 14% (30/208) of fistulas failed within 6 weeks and that the 1-year patency rate was 65%7; by comparison, other authors have reported 1-year patency rates ranging from 61%[7–8] to over 90%.[6,11]

TABLE 2. Correlation between cephalic vein size and maturation of arterio-venous fistulas.

Clinical factors	No. of patients (%)	Maturation (%) Primary vs primary-assisted vs secondary	P-value
Gender			0.09
Male	25 (64.1%)	68.0% vs 72.0% vs 92.0%	
Female	14 (35.9%)	42.9% vs 50.0% vs 71.4%	
Age group			0.05
< 50 years	14 (35.9%)	78.6% vs 78.6% vs 100%	
50-70 years	16 (41.0%)	43.8% vs 56.3% vs 75.0%	
> 70 years	9 (23.1%)	55.5% vs 55.5% vs 77.7%	
Diabetes mellitus			< 0.05
DM	21 (53.8%)	47.6% vs 47.6% vs 71.4%	
Non-DM	18 (46.2%)	72.2% vs 83.3% vs 100%	
CAD			n.s.
CAD	8 (20.5%)	50% vs 50% vs 75%	
Non-CAD	31 (79.5%)	61.3% vs 67.7% vs 87.1%	
Vein size (mm)			n.s.
< 2.0	9 (23.1%)	44% vs 55% vs 77%	
2-2.4	16 (41.0%)	63% vs 69% vs 94%	
2.5-2.9	10 (25.6%)	60% vs 60% vs 80%	
> 3.0	4 (10.3%)	75 % vs 75% vs 75%	

Abbreviation: n.s.= no statistical significance

Our autogenous snuffbox AVF-first approach resulted in an 84.6% success rate and a 1-year patency of 60.6%, both of which were comparable to other studies[12–13] as well as the outcomes of wrist radiocephalic arteriovenous fistula creations at our center.[14] Of the 6 patients (15.4%) who had a failed AVF, two underwent an AVG, two were given brachiocephalic arteriovenous fistulas, and two received catheter-based hemodialysis due to having borderline cardiac functions. However, of those who had a failed AVF, three had no suitable site for an AVF as they had a small venous diameter (< 2.5 mm); a small venous size was also observed in 9 patients for whom autogenous AVFs were successfully created.

Regarding vascular size as a determining factor for autogenous AVF creation, the results of the present study indicated that the SBAVF-first approach enhanced the autogenous AVF creation from 66.7% (26/39) to 89.7% (35/39).

The major disadvantages of this approach were its relatively long maturation time (mean, 3 months) and a high incidence of juxta-anastomosis stenosis at the wrist level, which frequently required transposition to a wrist radiocephalic arteriovenous fistula as a secondary procedure. Nonetheless, that procedure was able to be performed simply under local anesthesia due to the vessels being enlarged after the first fistula creation (Fig 3).

Diabetes had a significant association with failed SBAVF maturations, while being female and a patient age of over 50 years tended towards lower maturation rates. Although venous size was not significantly correlated with the maturation rate, a venous diameter of 3 mm or more did not require any intervention to assist maturation.

Fig 3. Transposition of left radio-cephalic arteriovenous fistula **(Left)** and Transposed left radio-cephalic arteriovenous fistula **(Right)**.

A venous size of less than 2.5 mm significantly correlated with a reduction in the 1-year patency rate. However, our sample size was relatively small and contained only a few patients who had a large venous diameter.

There are several measures to determine the factors affecting snuffbox AVF outcomes. In 2012, Twine et al. developed a DISTAL score by combining 6 factors (each factor representing 1 score) affecting fistula failure, namely, diabetes, ischemic heart disease, stroke, two snuffbox procedures, an age > 70 years, and a venous diameter of < 2 mm.[8] This DISTAL scoring system was used in our study (Table 4), and it revealed a significant correlation with the maturation rates but not with the patency rates. This can be explained by the DISTAL scoring system's use of a different cut-point for significant venous size (< 2 mm versus < 2.5 mm in the current study) and a patient age of > 70, which tended to lead to higher patency rates in our study (Fig 4).

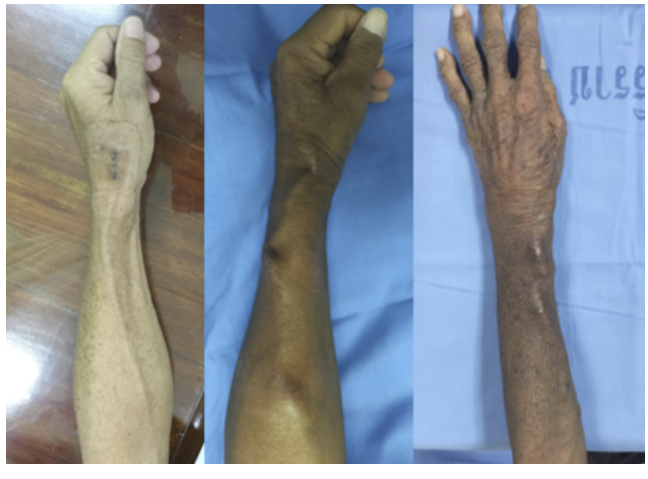


Fig 4. Outcomes of autogenous snuffbox radiocephalic AVF (Left) Early postoperative period, (Middle) in a 47 year-old male patient, and (Right) a 79 year-old female patient.

CONCLUSION

The study results suggest that an autogenous snuffbox radiocephalic arteriovenous fistula (SBAVF)-first strategy is feasible because of its relative ease of surgical access, its comparatively extended venous access area, and the provision of options for future AVF correction, especially in the case of young patients without diabetes and not in urgent need of hemodialysis. SBAVF could also be considered in cases of borderline venous size in order to enhance the rate of autogenous arteriovenous fistula for hemodialysis.

TABLE 3. Correlation between clinical factors and 1-year primary patency rates.

Clinical factors	No. of patients (n = 33)*	Patency rates (%)	P-value
Gender			n.s.
Male	23 (69.7%)	65.2%	
Female	10 (30.3%)	50.0%	
Age group			0.056
< 50 years	14 (42.4%)	57.1%	
50-70 years	12 (36.4%)	50.0%	
> 70 years	7 (21.2%)	85.7%	
Diabetes mellitus			n.s.
DM	15 (45.4%)	73.3%	
Non-DM	18 (54.5%)	50.0%	
CAD			n.s.
CAD	6 (18.2%)	83.3%	
Non-CAD	27 (81.8%)	55.6%	
Venous size (mm)			< 0.05
< 2 mm	7 (21.2%)	28.6%	
2-2.4 mm	15 (45.4%)	53.3%	
2.5-2.9 mm	8 (24.3%)	87.5%	
> 3 mm	3 (9.1%)	100%	

*Patients in whom the AVF failed to mature were excluded.
Abbreviation: n.s.= no statistical significance

The follow-up period range was 12–50 months (median, 29 months). The patency results are demonstrated in Kaplan–Meier plots in Fig 2; the primary, primary-assisted, and secondary patency rates at 12 months were 60.6%, 81.8%, and 100%, respectively; and at 24 months were 51.5%, 72.7%, and 97.0%, respectively. A Cox regression analysis evaluating the clinical factors (age group, gender, diabetes, and vein size) and 1-year primary patency rates demonstrated significantly lower primary patency rates in patients whose cephalic venous size was < 2.5 mm.

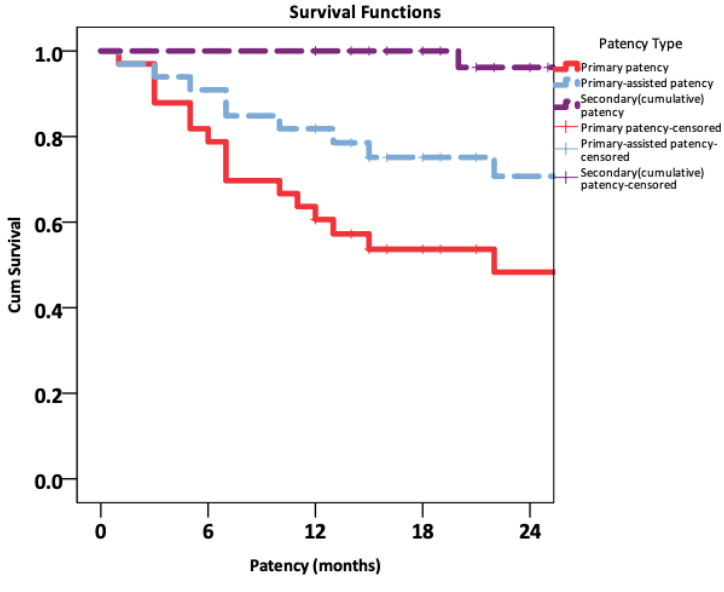


TABLE 4. Correlations between distal scores, maturation rates, and 1-year patency rates.

Distal score	No. of patients (n=39)	Maturation rate*	No of AVFs (n=33)	1-year primary patency rate[n.s.]
0	10 (25.6%)	100%	10	50%
1	17 (43.6%)	88.2%	15	50.0%
2	4 (10.3%)	75%	3	66.7%
3	8 (20.5%)	62.5%	5	80.0%

*$p < 0.05$,
Abbreviation: n.s.= no statistical significance

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