The THAI Journal of SURGERY 2015;36:131-134
Official Publication of the Royal College of Surgeons of Thailand

Original Article

Optimized Native Arteriovenous Fistulae for Chronic Hemodialysis

Anuwat Chanthip, MD, FRCST
Department of Surgery, Lampang Regional Hospital, Lampang, Thailand

Abstract

Background and Objective: **The arteriovenous fistulae (AVF) is the preferred vascular access for hemodialysis in terms of superior primary patency, longer access survival and decrease morbidity and mortality compared with AV grafts. Recent clinical practice guideline (NKF/DOQI) advocates increase native AVF to achieve 65%. This study was attempted to create native arteriovenous fistulae with simple preoperative assessment and criteria for both new hemodialysis and previous permanent access patients.**

Objective: **The purpose of this study was to delineate preoperative assessment and operative procedure for native arteriovenous fistulae to meet primary patency and sufficiency for hemodialysis.**

Material and methods: **Prospective study design was carried out at Lampang Regional Hospital between April 2005 and Nov 2010 by one surgeon. Preoperative assessments comprised of physical examination and duplex imaging study of vein and artery of non-dominant upper extremity first. The criteria are wrist vein diameter > 2.5 mm, arterial diameter > 2.0 mm with no inflow and outflow stenosis. The creation of arteriovenous fistulae was regarded on the results of physical examination and preoperative duplex imaging. If the arteriovenous fistulae failed to mature, remedial imaging before re-intervention was performed.**

Result: **One hundred seventy-five patients with total 209 procedures were included in this study. Majority of the new hemodialysis cases had prior catheter placement for chronic hemodialysis. Total new hemodialysis, 149 patients, had first visit at Lampang Regional Hospital. One hundred forty-seven native AVF creation (98.6%) were performed with radiocephalic (77.8%), brachiocephalic (16.7%), forearmbasilic transposition (0.0067%), arm basilic transposition (0.0067%) and basilic superficialization (0.0268%). New hemodialysis patients had unsuitable criteria of duplex imaging for eight cases, only two cases were decided to operate with loop forearm AVBG. Twenty-six patients had at least one arteriovenous fistulae procedure from other hospital and had remedial procedure for 21 native AVF creation (80.7%) and 5 prosthetic graft (19.2%). One hundred forty-one native AVF matured after first creation, 22 patients needed remedial procedure, 3 patients needed 2 times of remedial procedure and 2 patients needed 3 times. All of these AVF patients had no mortality and limited number of complication such as thrombosis, bleeding and postoperative edema.**

Conclusion: **On the basis of native AVF creation first, with simple preoperative assessment. Optimized native AVF can reach over DOQI recommendation.**

Keywords: **Native arteriovenous fistulae, hemodialysis, duplex imaging**

Introduction

Native arteriovenous fistulas are preferred as vascular access of choice for permanent hemodialysis. In comparison to prosthetic graft and tunneled cuff catheter, native arteriovenous fistulae has the best primary and long term patency, requires fewest intervention and lowest incidence of morbidity and mortality[1-4]. For this reason, the National Kidney Foundation Kidney Disease Outcomes Quality Initiative (NKF-KDOQI) recommended that the native arteriovenous fistulae be constructed in at least 65% of all new hemodialysis patients[5].

Correspondence address: *Anuwat Chanthip, MD, FRCST, Department of Surgery, Lampang Regional Hospital, Paholyotin Road, Amphur Muang, Lampang 52000, Thailand; Telephone: +66 5423 7400; Fax: +66 5423 7444; E-mail: achansur@hotmail.com*

Among the common type of native arteriovenous fistulae, the radiocephalic fistulae is commonly recognized as the best vascular access for hemodialysis because of its fewer complication and longer patency[6]. The optimal fistulae configuration for native arteriovenous fistulae was selected according to quality of blood vessels, anatomical area, obesity and feasibility. This study was designed and attempted to optimize the native arteriovenous fistulae for new hemodialysis and previous permanent access failure patients.

Table 1 Suitable criteria of forearm artery and vein for native forearm AVF

Artery:	- Diameter ≥ 2.0 mm - Intact palmar arch (Allen test positive) - Non dominant arm first
Vein:	- Diameter ≥ 2.5 mm - Demonstrated flow by duplex ultrasound (no significant outflow stenosis) - Venous tapping sign for at least 10 cm venous segment Intra-operative pass through NG catheter no.8 with 10 ml. 0.9% NSS injection without resistant

Material and Methods

The study was conducted at Lampang Regional Hospital and prospectively enrolled all of upper extremity hemodialysis access between April 2005 and November 2010. Ethical approval was obtained from Lampang Regional Hospital Research Ethics Committee. Type of fistulae creation was determined after physical examination, Allen's test and duplex imaging of upper extremity blood vessels. Non invasive duplex arterial /venous imaging of non-dominant arm were obtained in radial artery, ulna artery, radiocephalic vein, brachial artery, arm cephalic/basilic vein and subclavian vein. The patency and diameter of these vessels were determined. The fistulae configurations were radiocephalic, antecubital, brachiocephalic, brachiobasilic or vein transposition fistula. After operation, the patients were followed with physical examination and remedial duplex imaging were performed in selected case until maturation or failure. A total of 209 arteriovenous fistulae procedures were performed in 175 patients by one surgeon. Mean patient age at the time of operation was 57 ± 12 years, nearly half (45%) of them were diabetic and 6 cases were obese (BMI >30 kg/m^2). New hemodialysis access procedures were constructed in 149 patients, the remaining 26 patients underwent at least one procedure for upper extremity of arteriovenous fistulae at other hospitals. The native arteriovenous fistulae configuration was selected depending on physical examination and the criteria shown in Table 1.

Operative technique

The most frequently used technique of anastomosis is end of vein to side of artery for both arm and forearm procedure. In most cases, general anesthesia with normal temperature operating theater was used. Preoperative duplex scan of suitable blood vessels were reexamined directly during dissection. Venous outflow adequacy, patency and continuity were routinely examined with 10 ml of NSS flushing through NG catheter no. 8, then anastomosis of AVF were performed with loupe magnification (2.5X) and suturing with double end 6/0 prolene. After the procedure, the patients were followed up in the outpatient clinic at 1 week after discharge and next 6-8 weeks for evaluation and further hemodialysis. Patients who failed to develop fistulae maturation within 6-8 weeks (absence of palpable thrill presumed as stenosis) or those with acute complication precluded fistulae maturation, the different types of remedial procedure were performed. Success of fistulae for hemodialysis was determined as the patient underwent dialysis with the fistulae cannulation on at least three occasions.

Statistical analysis

Descriptive statistics were presented as mean and percentages. Fisher's exact test was applied for categorical variable. Statistical significance was considered when $p < 0.05$.

RESULTS

Most of the patients in this study had previous hemodialysis catheter placement. Less than 20 patients had only preoperative physical examination to determine the choice of AVF. One hundred seventy-five patients with 209 procedures were included in this study. Ninety-four percent of patients (141/149 patients) were appropriated with criteria (Table 1).

New hemodialysis fistulae creation was conducted in 149 patients, 26 patients underwent previous AVF creation at other hospitals. Eight patients did not meet the criteria for primary native common fistulae creation. Seventy-seven percent of patients were selected for Brescia-Cimino radiocephalic fistulae, 16.7% were suitable for arm brachiocephalic AVF, there was no correlation of the two most common fistulae configuration, $p = 0.114$ (Table 2). Patients with abnormal findings after physical examination and duplex imaging (5.36%), calcified wrist artery with significant arterial occlusive diseases (cannot identify arterial waveform), used mid or proximal forearm radial or ulna artery for inflow anastomosis.

Primary native radiocephalic fistulae did not sufficiently progress within 6-8 weeks including, post operative bleeding (2 cases), failure fistulae maturation (26 cases), acute complication from postoperative thrombosis (7 cases) and late compli-cation from post-puncture thrombosis (4 cases). Remedial imaging and intervention were performed proximal to the previous surgical site (ante-cubital for 4 cases, brachiocephalic for 22 cases, anastomosis revision for 9 cases and patch angioplasty for 4 cases).

The patients who did not meet the criteria were decided to have fistulae configuration with forearm transposition (radiobasilic) 1 case, arm basilic transposition 1 case, arm basilic superficialization 4 cases and 2 cases of loop forearm AVBG. The arteriovenous fistulae configuration and revision procedure (26 cases) from other hospitals are shown in Table 4. Revision procedure was performed after remedial duplex imaging. Adjunctive procedures were performed with native AVF in 80.7% (21/26 patients) and prosthetic graft placement in 19.3% (5/26 patients) and there was no peri-operative morbidity and mortality. The fistulae matured sufficiently for hemodialysis cannulation in 84.5% (148/175 patients) at first time after operation. Twenty-seven patients (18.2%) needed remedial procedure (2 times for 84%, 3 times for 11.1% and 4 times for 7.4%). A total of seven patients in this study underwent prosthetic graft procedure

Table 2 Compare the two most common fistulae configuration and maturation for dialysis

	Radiocephalic (%)	Brachiocephalic (%)	Total (%)
Maturation	81 (69.83)	21 (84.00)	102 (72.34)
Failure	35 (30.17)	4 (16.00)	39 (27.66)
Total	116 (100)	25 (100)	141 (100)

Table 3 New hemodialysis cases and access configuration

Configuration	Number (%)	Maturation (%)	Failure (%)
Radiocephalic	116 (77.8)	81 (69.8)	35 (30.1)
Brachiocephalic	25 (16.7)	21 (84)	4 (16)
Forearmbasilictranspositon	1 (0.0067)	1 (100)	0
Armbasilictransposition	1 (0.0067)	1 (100)	0
Basilicsuperficialization	4 (0.02)	4 (100)	0
Loop forearm AVBG	2 (0.01)	2 (100)	0

Table 4 Prior procedure from other hospital and remedial intervention

Previous operation	No.	Remedial intervention	No. (%)
Brachioaxillary	3	Segmental graft	2 (7.6)
Loop forearm AVBG	3	Proximal jump graft	1 (3.8)
Radiocephalic	14	Native	3 (11.5)
Post puncture thrombosis	4	brachiocephalic	12 (46.1)
Brachiocephalic AVBG	2	Proximal radiocephalic	2 (7.6)
		Brachiocephalic	4 (15.3)
		Proximal revision segmental graft	2 (7.6)

Table 5 New hemodialysis and previous permanent access failure with the used of native AVF and prosthesis

	New hemodialysis (%)	Previous access (%)	Total (%)
Native AVF	147 (98.66)	21 (80.77)	168 (96.00)
Prosthetic graft	2 (1.34)	5 (19.23)	7 (4.0)
Total	149 (100)	26 (100)	175 (100)

p-value = 0.001

(two cases of new hemodialysis and five cases who had failure AVF at other hospitals). Two cases of new hemodialysis had inadequate wrist vessels diameter, then loop forearm AVBG was performed and five cases with prior AVF procedure had brachioaxillary graft for three cases. Segmental prosthetic grafts were used in two cases. The native graft was the preferred choice for new hemodialysis patient, $p = 0.001$ (Table 5).

Discussion

Native AVF is the best permanent vascular access for chronic hemodialysis to improve overall outcome of hemodialysis patients. The National Kidney Foundation Kidney Diseases Outcomes Quality Initiative (NKF-KDOQI) guideline recommended native AVF at least 65% for new hemodialysis patients. Ascher et al. examined impact of DOQI and reported an increase in the use of native fistulae from 5% to 68%[7]. Preoperative sonographic mapping was used before access construction[8]. Mihmanli et al. reported that the success rate for native AVF was better in patients with pre-operative noninvasive imaging when compared with physical examination alone[9-10]. The preference of autogenous over prosthetic graft construction optimized the use of native AVF[11]. The practice pattern of AVF creation depended on physical examination, duplex imaging and all possible native AVF creation.

In this study, all of the patients including those with prior procedure for hemodialysis are candidate for native AVF. Native fistulae creation was planned for more than 95% of patients with an attempt to select a fistulae configuration that was most likely to be successful. Preoperative physical examination and noninvasive imaging was beneficial to confirm the choice of fistulae configuration and can demonstrate forearm arterial calcification among patients with diabetes, obese patients and the elderly. These evaluation had the impact on operative plan and site selection such as radiocephalic, brachiocephalic, transposition procedure and further decision to use prosthetic graft instead.

References

1. Feldman HI, Kobrin S, Wasserstein A. Hemodialysis vascular access morbidity. J Am Soc Nephrol 1996;7:523.
2. Ascher E, Gade P, Hingorani A, et al. Changes in the practice of angioaccess surgery: impact of dialysis outcome and quality initiative recommendations. J Vasc Surg 2000;31: 84.
3. Allon M, Robbin ML. Increasing arteriovenousfistulas in hemodialysis patients: problems and resolutions. Kidney Int 2002;62:1109.
4. Dixon BS, Novak L, Fangman J. Hemodialysis vascular access survival: upper arm native arteriovenous fistula. Am J Kidney Dis 2002;39:92.
5. NKF-K/DOQI Clinical Practice Guidelines For Vascular Access: Update 2006. Guideline 8: Clinical outcome goals, 8.1 goals for access placement, 8.1.2 prevalent functional AVF placement rate.
6. Sidawy AN, Spergel LM, Besarab A, et al. The Society for Vascular Surgery: clinical practice guidelines for the surgical placement and maintenance of arteriovenous heodialysis access. J Vasc Surg 2008;48:2S.
7. Ascher E, Gade P, Hingorani A, Mazzariol F, Gunduz Y, Fodera M, et al. Changes in the practice of angioaccess surgery: impact of dialysis outcome and quality initiative recommendations. J Vasc Surg 2000;31:84-92.
8. Allon M, Lockhart ME, Lilly RZ, Gallichio MH, Young CJ, Barker J, et al. Effect of preoperative sonographic mapping on vascular access outcomes in hemodialysis patients. Kidney Int 2001;60:2013-20.
9. Mihmanli I, Besirli K, Kurugoglu S, Atakir K, Haider S, Ogut G, et al. Cephalic vein and hemodialysis fistula: surgeon's observation versus color Doppler ultrasonographic findings. J Ultrasound Med 2001;20:217-22.
10. Silva MB Jr, Hobson RW, Pappas PJ, Jamil Z, Araki CT, Godberg MC, et al. A strategy for increasing use of autogenous hemodialysis access procedures: impact of preoperative non invasive evaluation. J Vasc Surg 1998; 27:302-7.
11. Miller A, Holzenbein TJ, Gottlieb MN, Sacks BA, Lavin PT, Goodman WS, et al. Strategies to increase the use of autogenous arteriovenous fistula in end-stage renal disease. Ann Vasc Surg 1997;11:397-405.