

## Clinical Analysis of Radiocephalic Fistula Using Side-to-side Anastomosis with Distal Cephalic Vein Ligation

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**Background:** The surgically created arteriovenous fistula has recently been recommended as the best available angioaccess for hemodialysis. Therefore, in this study, we carried out a clinical analysis on surgical procedures in the ligation and division of a distal vein to achieve similar effects as those of vein end-to-arterial side after side-to-side anastomosis. **Methods:** We retrospectively reviewed the clinical data of 113 patients who came for an outpatient clinic follow-up to the department of internal medicine of our hospital; these patients were among the 125 patients who underwent radiocephalic arteriovenous fistula (side-to-side anastomosis with distal vein ligation and division) in our hospital in the period from January 2006 to December 2010. **Results:** The patency rate showed no statistical significance with respect to sex ( $p=0.775$ ), age ( $p=0.775$ ), hypertension ( $p=0.262$ ), diabetes ( $p=0.929$ ), and cardio-neurovascular disease ( $p=0.717$ ). Patency rates were 96% for the first month, 93% for the first year, and 90% for the second year for the radiocephalic arteriovenous fistula (side-to-side anastomosis with distal vein ligation and division) performed on the wrist. **Conclusion:** The patency rates revealed favorable results and few postoperative complications as compared to those of previous reports. Therefore, radiocephalic fistula using side-to-side anastomosis with distal cephalic vein ligation is considered a recommendable surgical procedure in the distal part for the hemodialysis of CRF patients.

Key words: 1. Radiocephalic fistula  
2. Arteriovenous fistula  
3. Distal cephalic vein ligation  
4. Side-to-side anastomosis

### INTRODUCTION

According to the End-stage Renal Disease Registry Committee of the Korean Society of Nephrology, of 58,860 patients (1,144.4/million) who underwent renal replacement therapy in Korea in 2011, 39,509 patients (67%) received hemodialysis, 7,309 patients (12%) received peritoneal dialysis, and 12,042 patients (21%) underwent kidney transplantation.

Hemodialysis is the most commonly performed renal replacement therapy before kidney transplantation. The surgically created arteriovenous fistula (AVF) has recently been recommended as the best available angioaccess for hemodialysis by the National Kidney Foundation's Kidney Disease Outcomes Quality Initiative guidelines [1]. The most frequent cause of chronic kidney disease (CKD) in North America and Europe is diabetic nephropathy, most often secondary to type 2 dia-

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Received: March 19, 2013, Revised: June 25, 2013, Accepted: July 15, 2013

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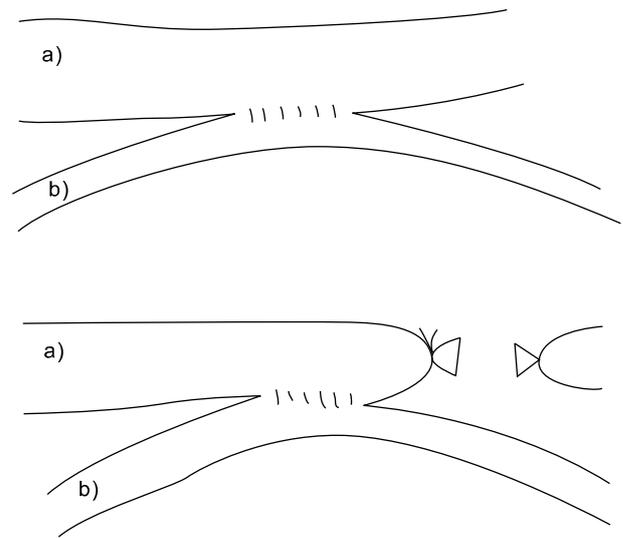
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betes mellitus. Patients with newly diagnosed CKD often also suffer from hypertension. Different types of techniques have been used for the anastomosis of the artery and vein. The most commonly reported techniques include the following: 1) end of artery to end of vein, 2) end of artery to side of vein, 3) side of artery to end of vein, and 4) side of artery to side of vein [2]. Different studies have reported different incidences of complications among these types of AVF. End-to-end anastomosis has the lowest fistula rate, and arterial end-to-venous side fistula has the greatest risk of venous hypertension [3]. Side-to-side anastomosis is the most commonly used technique and has been described to be the easiest to construct technically [3]. However, this procedure has the greatest risk of venous hypertension. Vein end-to-arterial side anastomosis is a highly recommended procedure because it has the highest proximal venous flow and a relatively low risk of venous hypertension. In this study, we carried out a clinical analysis on surgical procedures in the ligation and division of a distal vein to achieve similar effects as those of venous end-to-arterial side artery after side-to-side anastomosis. A similar study has been reported by Ahsan et al. [2] outside of Korea. Our study was conducted because only a few studies have been reported in Korea.

## METHODS

Of the 125 patients who underwent radiocephalic AVF (side-to-side anastomosis with distal vein ligation and division) in the department of thoracic and cardiovascular surgery in our hospital from January 2006 to December 2010, in this study, we included 113 patients who came for an outpatient clinic follow-up to the department of internal medicine of our hospital. We excluded 10 patients who were unable to come for the routine outpatient follow-up and 2 patients who died because of medical problems. We carried out a retrospective study based on medical records. Surgery was primarily performed on the left wrist of the patients. The procedure was performed on the right wrist if the status of the left vein was unfavorable or if the patient was left handed. Preoperatively, all patients were assessed clinically using standard methods including the Allen test and a pressure cuff application. A 2-cm longitudinal incision was made after injecting the oper-



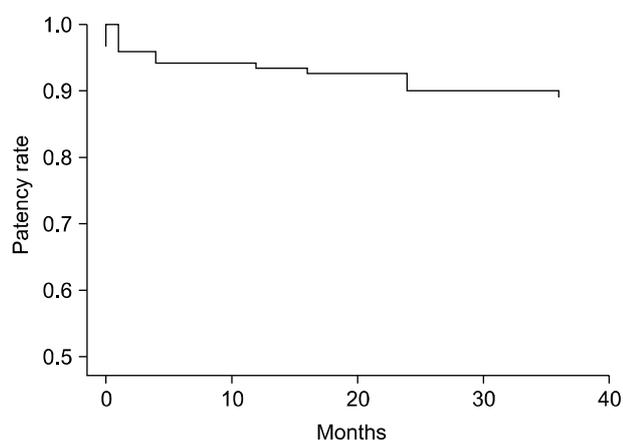
**Fig. 1.** Radiocephalic fistula using side-to-side anastomosis and radiocephalic fistula using side-to-side anastomosis with distal cephalic vein ligation. <sup>a)</sup>Cephalic vein; <sup>b)</sup>radial artery.

ation site with 2% lidocaine. The radial artery and the cephalic vein were dissected. Subsequently, arteriotomy and venotomy were performed after clamping two vessels in the cephalic vein and the radial artery by using a bulldog vascular clamp. Side-to-side vascular anastomosis was conducted using a 7-0 prolene suture. The presence of thrill, bleeding, stenosis, or other complications was checked after continuous suturing, and then, the distal end of the vein was ligated and divided (Fig. 1). The proximal venous run-off in the cephalic vein was examined using a coronary dilator and that was performed in the distal opening during venous anastomosis too. In the case of an unsatisfactory outcome, balloon dilation and cephalic vein thrombectomy were performed several times by using a Fogarty catheter in the cephalic vein. After confirming the presence of thrills, the distal venous opening was ligated. A single thoracic surgeon operated on the patients using the same procedure to prevent a difference in results generated by the use of different procedures. Patients were reviewed retrospectively on the basis of the medical record of patency rates and complications. The 113 patients included were divided and compared according to the patency rates for the first month, the first year, and the second year after surgery depending on gender and the incidence of hypertension, diabetes mellitus, and cardio-neurovascular disease. A patient

**Table 1.** Patient characteristics and p-values

Characteristic	Value	p-value
Gender		0.867
Male	89 (79)	
Female	24 (21)	
Total	113	
Age (yr)		0.775
Below 65	22 (19)	
Over 65	91 (81)	
Underlying disease		
Diabetes	39	0.929
Hypertension	82	0.262
Cardio-neurovascular disease	13	0.717

Values are presented as number (%).



**Fig. 2.** Patency rate of radiocephalic fistula using side-to-side anastomosis with distal cephalic vein ligation. Survival analysis: Cutler-Ederer method.

was considered an early failure in the case of no AVF maturation or reoperation within a month. Only physical examination was conducted for a preoperative venous evaluation except for unusual cases. The patency rate was assessed using the Cutler-Ederer method, a method of survival analysis, and the results for the different surgical techniques were compared with the results of previous studies reported domestically. A result was interpreted as statistically significant when the corresponding p-value was less than 0.05.

## RESULTS

The ratio of the number of males to females was 89:24.

**Table 2.** Patency rate except for early failure cases in Korea

Authors	Type	1 year (%)	2 year (%)
Chung et al. [4]	Radiocephalic	70-84	64-78
	Brachiocephalic	82	77
	Polytetrafluoroethylene	70	68
Seong et al. [5]	Snuffbox	72	64.9
Cho et al. [6]	Overall	72	72
Yoon et al.	Radiocephalic (side-to-side with distal vein ligation)	93	90

**Table 3.** Causes of arteriovenous fistula failure

Variable	Value
Thrombotic occlusion	7 (54)
Venous hypertension	3 (23)
Cephalic vein stenosis	2 (15)
Poor function	1 (8)
Total	13 (0)

Values are presented as number (%).

There were 91 patients aged more than 65 years and 22 patients aged less than 65 years. The mean age was  $49.9 \pm 15.31$  years. The most common complication associated with CRF was hypertension (in 82 patients), followed by diabetes mellitus (in 39 patients), and cardio-neurovascular disease (in 13 patients) (Table 1). The patency rate showed no statistical significance with respect to sex ( $p=0.775$ ), age ( $p=0.775$ ), hypertension ( $p=0.262$ ), diabetes ( $p=0.929$ ), or cardio-neurovascular disease ( $p=0.717$ ) (Table 1). The patency rates were 96% for the first month, 93% for the first year, and 90% for the second year for the radiocephalic AVF (side-to-side anastomosis with distal vein ligation and division) performed on the wrist (Fig. 2). The patency rates for the first and the second years were compared with those of previous studies conducted domestically (Table 2) [4-6]. Fistula failure occurred in 13 patients during the follow-up. The most common cause of fistula failure was thrombotic occlusion (7 patients), followed by venous hypertension (3 patients), cephalic vein stenosis (2 patients), and poor function (1 patient) (Table 3).

## DISCUSSION

The mean age of the included patients was  $49.9 \pm 15.31$

years, showing an insignificant difference compared with other similar studies. The ratio of males to females was approximately 8:2, showing that this study considered relatively more males than another study with the male-to-female ratio of 6:4 [7]. Dialysis is indispensable in CRF patients who did not undergo kidney transplantation. Therefore, the most fundamental and crucial factor in hemodialysis treatment is securing vascular access for sufficient blood flow. Although Kolff et al. [8] performed the first clinical hemodialysis in 1943, the sacrifice of peripheral vessels was almost unavoidable in hemodialysis patients. Quinton et al. [9] introduced the first external AVF construction using rigid Teflon tubing in 1960. However, this hemodialysis technique could not be applied long-term because of complications including thrombus, infection, and bleeding. Subsequently, Brescia et al. [10] first described internal AVF construction in 1966 and enabled repeatable long-term hemodialysis with a low risk of infection. Brescia et al. [10] introduced internal AVF between the radial artery and the cephalic vein, also called the Brescia-Cimino procedure, which has been recognized as the most common surgical technique for internal AVF construction. Cascardo et al. [11] described the side-to-side brachiocephalic fistula in 1970 and Gracz et al. [12] introduced perforating vein AVF in 1977. Mehigan and McAlexander [13] suggested procedures for the creation of AVF at the snuffbox for proximal vascular preservation in 1982. The ideal AVF provides adequate blood flow without any complications in the long term. However, repeated vessel punctures during prolonged hemodialysis lead to the development of vessel injuries, which in turn lead to thrombosis or obstruction. Therefore, additional AVF construction is essential. The duration of use of the AVF is profoundly correlated to the lifespan of patients with CRF. Taking reoperation into account, the distal part needs to be considered the primary surgical site. The surgical procedure of radiocephalic AVF (side-to-side anastomosis with distal vein ligation and division) is performed in the distal part with easier procedures than other surgical techniques and has fewer complications with similar effects as those of vein end-to-side arterial anastomosis. Early failure is the condition of being unable to perform hemodialysis because of an obstructed anastomotic site and insufficient blood flow within one month after the

AVF. The possible causes of early failure include the use of inappropriate vessels, and lack of dilatation due to perivascular fibrosis, intraoperative vessel intimal injury, low blood pressure, or thick subcutaneous fat tissue [14]. Approximately 4% of the cases exhibited early failure in the study; such early failure could be minimized by reducing the attributable causes mentioned above. The risk factors affecting the early obstruction of AVF are reported to be age, gender, diabetes mellitus, and association of complications including hypertension and cardiovascular disease [15,16]. Unlike early obstruction, thrombus formation and vessel stenosis could occur because of repeatedly punctured vessels. To prevent these, vessel injury needs to be minimized by changing the puncture site. A large number of studies have identified the risk factors affecting the patency rate of AVF and commonly suggested the size and the condition of the vein and insufficient venous blood flow as the crucial factors influencing the early success rate [17-19]. Therefore, the evaluation of the preoperative vein status is thought to be beneficial in anticipating postoperative fistula maturation. Preoperative vein status could be examined through ultrasonography, venography, physical examination, or other methods. However, the most favorable screening methods remain unclear. In 2009, Lauvao et al. [20] reported that no differences were found in the outcome of maturation between the group that underwent a venogram and the group that underwent a physical exam. Since physical exams were thought to be sufficient for predicting preoperative vein status, ultrasonography, venography, and other tests were not performed in our patients.

In conclusion Brescia-Cimino fistula is the most common and primary fistula for hemodialysis of patients with CRF along with radiocephalic fistula (side-to-side anastomosis). Although several previous studies have reported the surgical progress and clinical review on distal AVF, only a few studies, such as this study, have investigated radiocephalic fistula (side-to-side anastomosis with distal vein ligation). The radiocephalic fistula (side-to-side anastomosis with distal vein ligation) method carried out in our hospital is easier to perform and has a relatively low risk of venous hypertension. Furthermore, this procedure is considered the desirable primary AVF since fistula could be recreated proximally in the case of failure. The patency rates were 93% for the first year

and 90% for the second year, showing favorable results compared with those of previous reports. Therefore, radiocephalic fistula using side-to-side anastomosis with distal cephalic vein ligation is considered a recommendable surgical procedure in the distal part for the hemodialysis of CRF patients.

### CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

### REFERENCES

1. Vascular Access 2006 Work Group. *Clinical practice guidelines for vascular access*. Am J Kidney Dis 2006;48 Suppl 1:S176-247.
2. Ahsan ZU, Waheed A, Zaeem FA, Nazir F. *Arteriovenous fistulas constructed using side-to-side anastomosis with ligation and division of distal venous arm: a tertiary care hospital experience*. J Vasc Access 2010;11:26-30.
3. Bennion RS. *Autogenous arteriovenous fistula*. In: Strandness DE, Breda AV, editors. *Vascular diseases: surgical and interventional therapy*. New York: Churchill Livingstone; 1994. p. 1048.
4. Chung KY, Kim YS, Cho HR, et al. *The importances of size or status of cephalic vein during formation of internal vascular access*. J Korean Surg Soc 1993;44:273-8.
5. Seong SW, Song MH, Sung GY, et al. *Clinical analysis of anatomical snuffbox arteriovenous fistula*. J Korean Vasc Surg Soc 1998;14:316-20.
6. Cho LH, Yu HC, Jung SH, Cho BH. *Clinical experience with internal arteriovenous fistula formation*. J Korean Vasc Surg Soc 1998;14:321-9.
7. Cho HG, Moon IS, Park JS, Koh YB. *Clinical experience of AV fistula hemodialysis of chronic renal failure patients*. Korean J Vasc Endovasc Surg 1995;12:121-7.
8. Kolff WJ, Berk HT, Welle NM, van der Ley AJ, van Dijk EC, van Noordwijk J. *The artificial kidney: a dialyser with a great area*. Acta Med Scand 1944;117:121-34.
9. Quinton W, Dillard D, Scribner BH. *Cannulation of blood vessels for prolonged hemodialysis*. Trans Am Soc Artif Intern Organs 1960;6:104-13.
10. Brescia MJ, Cimino JE, Appel K, Hurwich BJ. *Chronic hemodialysis using venipuncture and a surgically created arteriovenous fistula*. N Engl J Med 1966;275:1089-92.
11. Cascaro S, Acchiardo S, Beven EG, Popowniak KL, Nakamoto S. *Proximal arteriovenous fistulae for haemodialysis when radial arteries are unavailable*. Proc Europ Dial Transplant Assoc 1970;7:42-6.
12. Gracz KC, Ing TS, Soung LS, Armbruster KF, Seim SK, Merkel FK. *Proximal forearm fistula for maintenance hemodialysis*. Kidney Int 1977;11:71-5.
13. Mehigan JT, McAlexander RA. *Snuffbox arteriovenous fistula for hemodialysis*. Am J Surg 1982;143:252-3.
14. Marx AB, Landmann J, Harder FH. *Surgery for vascular access*. Curr Probl Surg 1990;27:1-48.
15. Wong V, Ward R, Taylor J, Selvakumar S, How TV, Bakran A. *Factors associated with early failure of arteriovenous fistulae for haemodialysis access*. Eur J Vasc Endovasc Surg 1996;12:207-13.
16. Tonelli M, Hirsch DJ, Chan CT, et al. *Factors associated with access blood flow in native vessel arteriovenous fistulae*. Nephrol Dial Transplant 2004;19:2559-63.
17. Reilly DT, Wood RF, Bell PR. *Prospective study of dialysis fistulas: problem patients and their treatment*. Br J Surg 1982;69:549-53.
18. Palder SB, Kirkman RL, Whittmore AD, Hakim RM, Lazarus JM, Tilney NL. *Vascular access for hemodialysis. Patency rates and results of revision*. Ann Surg 1985;202: 235-9.
19. Jang JY, Hwang BK, Ha WS, et al. *A clinical study for the factors influencing early patency of internal arteriovenous fistula in chronic renal failure patients*. J Korean Surg Soc 1991;41:635-40.
20. Lauvao LS, Ihnat DM, Goshima KR, Chavez L, Gruessner AC, Mills JL Sr. *Vein diameter is the major predictor of fistula maturation*. J Vasc Surg 2009;49:1499-504.