Selective two-stage basilic and cephalic vein transpositions can significantly improve the rate of fistula construction

Homayoun Hashemi MD FACS FICA¹, Michael J Sheridan ScD FACE², Beverly Ford RN MSN¹

H Hashemi, MJ Sheridan, B Ford. Selective two-stage basilic and cephalic vein transpositions can significantly improve the rate of fistula construction. *Int J Angiol* 2009;18(3):129-134.

INTRODUCTION: Modified proximal radial artery arteriovenous fistula (MPRAVF) can be used to improve the success and patency of basilic vein transposition (BVT) and cephalic vein transposition (CVT). In the present study, surgical experience with patients requiring a two-stage BVT or CVT using MPRAVF as the first stage was reviewed.

METHODS: All two-stage BVTs and CVTs performed between September 2004 and October 2006 were retrospectively reviewed. The median follow-up for this cohort was 23.7 months. One-year secondary patency of all transpositions was assessed.

RESULTS: Two hundred nineteen MPRAVFs were constructed. Twelve MPRAVFs failed and underwent a second procedure. Ninety-eight patients required no further procedures and their upper arm cephalic vein was matured and used for dialysis. Of 121 patients whose MPRAVFs were functioning but unusable due to their depth, 87 underwent BVT and 34 underwent CVT. The Kaplan-Meier one-year secondary patencies ($\pm$ standard error) for BVTs and CVTs were 0.90 ± 0.03 and 0.82 ± 0.06 , respectively. At one year, 87% of all transpositions remained patent.

CONCLUSIONS: Use of MPRAVF as the first stage of a two-stage BVT or CVT can significantly improve the patency rate of autogenous hemodialysis access placement beyond the 66% set forth by the Fistula First guidelines.

Key Words: Basilic; Cephalic; Fistula; Transposition

Fistula construction in the United States has remained steady for many years at approximately 30% to 40% (1,2). Other countries have reported higher success rates with primary autogenous hemodialysis access (3). Primary autogenous hemodialysis access has significantly improved since the new initiatives and goals set forth by Fistula First (www.fistulafirst.org). However, further improvement is required to reach the desired current goal of 66%.

Native access has the best five-year patency rate and requires fewer interventions compared with prosthetic grafts (4). Autogenous radiocephalic direct wrist access provides the best permanent access with the fewest complications (5). Unfortunately, only 30% of patients are candidates for this type of access. The usual approach is first to construct a radiocephalic access followed by a brachiocephalic access, and second, to place a forearm graft. However, the use of a forearm graft has resulted in loss of the basilic vein as an autologous conduit from subsequent graft revisions (6).

To increase the rate of fistula placement, in addition to constructing radiocephalic and brachiocephalic fistulas, other techniques must be used, such as forearm and upper arm basilic and cephalic transpositions. The present retrospective study reviews our experience with patients who underwent selective two-stage basilic vein transposition (BVT) and cephalic vein

transposition (CVT) using modified proximal radial artery arteriovenous fistula (MPRAVF) as the first stage.

METHODS

The office medical records of 293 patients were reviewed retrospectively. All patients underwent autogenous access placement by the primary author between September 2004 and October 2006 at the Inova Health System in Fairfax, Virginia, USA. All patients required permanent vascular access for hemodialysis. The majority of patients were being dialyzed using their existing tunnelled catheter or a failing graft or fistula. All patients were evaluated by physical examination, obtaining blood pressures in both arms and by Allen's test (7).

Subsequently, patients underwent routine vein mapping using duplex ultrasound examination. In some patients who had multiple previous accesses or long-term indwelling catheters, a venogram was performed to assess the patency of the central venous system. All patients underwent duplex ultrasound examination of their primary fistulas before the transposition.

The patients with a patent superficial vein greater than 2.0 mm to 2.5 mm underwent fistula placement. The algorithm followed was to construct a radiocephalic autogenous

¹Department of Surgery; ²Departments of Medicine and Psychiatry, Inova Health System, Fairfax, Virginia, USA

Correspondence and reprints: Dr Homayoun Hashemi, 2921 Telestar Court, Falls Church, Virginia 22042, USA. Telephone 703-280-5858, fax 703-849-0874, e-mail HYKL1@aol.com

access. If that was not possible, then an MPRAVF was constructed through a small longitudinal incision in the antecubital space just below the elbow. The median antebrachial vein was dissected out and distally ligated. Heparinized saline was used to dilate the vein.

Both cubital cephalic and basilic veins were visually inspected. If both veins were patent and their sizes were normal, they were not ligated. If a vein was too small, or diseased as a result of previous intravenous cannulation, then it was ligated. The deep communicating vein was routinely ligated to prevent flow into the deep system, and an end-to-side anastomosis was made to the proximal radial artery using an absorbable 7-0 PDS suture (Ethicon Inc, USA). In some patients whose antebrachial vein was diseased or thrombosed, but whose cubital veins were patent, the deep communicating vein was used and anastomosed to the brachial artery. In those patients whose antecubital veins were also occluded, the proximal forearm basilic vein was used as a conduit and was anastomosed to the proximal radial artery.

Patients were evaluated four to six weeks postoperatively with a duplex ultrasound to evaluate the size and patency of both cephalic and basilic veins. If the cephalic vein had matured, was superficial enough to be used, at least 6 mm in diameter and not stenotic, then no further procedure was performed. However, if the cephalic vein was too deep, then either a BVT or CVT was performed.

The decision concerning which vein to transpose was made on the basis of the ultrasound. Regardless of size, the larger of the two veins was used as long as it measured more than 5 mm to 6 mm. All the CVTs were performed under intravenous sedation using a few small-bridged incisions. The cephalic vein was completely dissected out and the cubital cephalic vein was transected in a bevelled fashion. A superficial tunnel was created using a Vectra tunneller (Bard Peripheral Vascular Inc, USA) to minimize damage to the vein. This device also allowed the operator to flush the vein and check for any twist in the vein before removing the sheath. The cephalic vein was reanastomosed to the cubital cephalic vein in an end-to-end fashion using two 7-0 PDS sutures to prevent a purse-string effect.

Seventy BVTs were performed under general anesthesia and 17 were performed with intravenous sedation and a mixture of lidocaine and bupivacaine administered locally. An incision was made from the cubital basilic vein to the junction of the basilic and axillary veins. All the tributaries were ligated and a subcutaneous tunnel was made in the same fashion as in CVT. If the cubital cephalic vein was patent, the cubital basilic vein was divided and reanastomosed in an end-to-end fashion after the vein was passed through the tunnel. If the cubital cephalic vein was not patent, the cubital basilic vein was divided and passed through the tunnel, and either reanastomosed to the same site in an end-to-end fashion or anastomosed to the brachial artery in an end-to-side fashion. All wounds were closed with two-layer subcutaneous closures. No patient received prophylactic antibiotics unless a revision with prosthetic material was required. All procedures were performed on an outpatient basis unless the patient was admitted to the hospital for other medical reasons.

All patients were evaluated two to three weeks postoperatively. If the fistula was patent, a routine ultrasound

was performed four weeks later. Ultrasound was performed regardless of the physical examination findings. If the ultrasound revealed any stenosis in the fistula, then a fistulogram was performed. If indicated, an intervention was conducted with either open-patch angioplasty or percutaneous angioplasty.

If the patient underwent revision of the fistula, then another ultrasound was obtained to document satisfactory elimination of stenosis. At this time, the patient was allowed to proceed with the use of their fistula. Thereafter, the patient was seen as needed, with no other routine follow-up ultrasound performed. However, all the patients were instructed to return to the office if any problems were encountered, such as excessive bleeding after dialysis, swelling, aneurysm formation or development of high pressures within the arteriovenous fistula. All follow-up information on the status of patients and their accesses was obtained by contacting the dialysis centres.

Primary patency was defined as the interval between fistula placement and the first intervention. Assisted primary patency was defined as the interval from the time of fistula placement until thrombosis or the time of measurement of patency, including intervening manipulations (surgical or endovascular intervention) designed to maintain the functionality of the access. Secondary patency was defined as the interval between access placement and failure, or time of follow-up to one year (7). A χ^2 analysis, using exact methods for all cells with less than five counts, was used to examine the frequency of complications and fistula success among the three groups. Kaplan-Meier estimates were calculated to examine the one-year secondary patency rates among groups. All statistical analyses were performed using SAS software (version 9.12, SAS Institute, USA).

RESULTS

During the 24-month study period, 293 patients underwent 473 procedures to construct native hemodialysis accesses. These procedures included 293 primary autogenous accesses, 121 transpositions and 21 second procedures performed on failed autogenous accesses. Thirty-eight interventions performed in all four groups after primary fistulas or transpositions were constructed. During the same period, 28 patients underwent brachial-axillary prosthetic graft placement. These patients did not have suitable veins for autogenous access placement. Patients who underwent revision of their existing graft were excluded. The mean follow-up period was 23.7 months. Patient demographics and complications are shown in Tables 1 and 2, respectively.

Twenty-eight per cent (83 of 293) of these patients were good candidates for radiocephalic access placement on the basis of physical examination and preoperative ultrasound or selective venogram. Eighty-nine per cent (74 of 83) of the fistulas in these patients remained patent and were used successfully for dialysis. Three failing fistulas required surgical intervention. Two patients were lost to follow-up, and in one of these patients the fistula thrombosed.

Two hundred ten patients who were not candidates for radiocephalic access formation, and nine patients whose radiocephalic access failed, underwent a MPRAVF procedure. Ninety-five per cent (207 of 219) of the MPRAVF procedures remained patent. Twelve patients whose original MPRAVF

TABLE 1
Patient demographics (n=293)

Mean age (range), years	57 (16–91)
Primary fistulas	
Male	167 (57)
Female	126 (43)
Hypertension	278 (95)
Diabetes mellitus	185 (63)

Data provided as n (%) unless otherwise indicated

procedure failed underwent the same procedure in the contralateral extremity and all 12 remained patent. Forty-five per cent (98 of 219) of the MPRAVF patients required no additional procedures and their cephalic veins were used for dialysis. Seven interventions were performed in the MPRAVF group. In this cohort, two fistulas thrombosed, two patients died and two patients were lost to follow-up.

Six weeks after the first stage was performed in 121 patients whose MPRAVFs were functioning but unusable due to their depth, 72% (87 of 121) underwent BVT and 28% (34 of 121) underwent CVT. On the basis of venous duplex ultrasound, the average diameter of the cephalic and basilic veins was 3.6 mm (range 2.4 mm to 4.9 mm) before their first-stage access placement. This increased to an average of 6.2 mm (range 4.1 mm to 8.2 mm), a 72% increase in the size of the veins four to six weeks later. Of the 87 BVTs, 95% (83 of 87) remained patent and were used successfully for dialysis. Of these BVTs, 28% (23 of 83) required intervention either before or after the use of the fistula. In this cohort, three fistulas thrombosed, one patient died and two patients were lost to follow-up.

One patient required ligation of his access secondary to massive swelling as a result of chronic central venous occlusion. Another patient required emergency ligation in the office secondary to massive bleeding which occurred as a result of a percutaneous stent angioplasty of the basilic vein performed by her nephrologist one week postoperatively. Of the 23 BVT interventions, 18 were open procedures and five were performed percutaneously.

Of the 34 CVTs, 91% (31 of 34) remained patent and were used for dialysis. Five fistulas underwent surgical revision, either before or after being used for dialysis. Two patients developed significant swelling secondary to their occluded central venous system and had to undergo ligation of their functioning transposition. One patient was lost to follow-up.

No statistically significant differences in complications among the three groups were found except for swelling (Table 2). There was significantly more swelling in the BVT and CVT groups, as would be expected in the presence of a central venous stenosis or occlusion. Under these circumstances, a high-flow proximal fistula (BVT and CVT) would have a greater probability of creating swelling than distal fistulas (radiocephalic and MPRAVF). The one-year secondary Kaplan-Meier patency rates were uniformly high, as shown in Table 3, and a log-rank test for equality showed no statistically significant differences in patency among the three groups ($P=0.61$). A historical comparison of the present results with the recent literature from 2000 to 2007 is shown (Table 4).

TABLE 2
Frequency of complications (n=340)

Complications	MPRAVF (n=219)	BVT (n=87)	CVT (n=34)
Infection	2	3	0
Hematoma	6	3	0
Steal syndrome	2	3	1
Swelling*	3	7	4
Myocardial infarction†	0	2	0
Death	0	1	0

Data presented as n. *Modified proximal radial artery arteriovenous fistula (MPRAVF) versus basilic vein transposition (BVT) ($P=0.007$), MPRAVF versus cephalic vein transposition (CVT) ($P=0.007$); †MPRAVF versus BVT ($P=0.08$)

Ninety-one per cent (268 of 293) of the patients who underwent construction of a fistula (primary or transposition) had a functioning fistula after one year (Table 5). Eighty-seven per cent (105 of 121) of the combined transpositions remained patent after one year. These results are in line with the reported results from Europe and Japan (8). However, 21 patients were required to undergo additional fistula construction (excluding two-stage transpositions) and 34 patients underwent 38 interventions (percutaneous and open) to achieve these results.

In the present patient series, the incidence of intervention was five times higher in the BVT/CVT group than in the radiocephalic/MPRAVF group ($RR=5.3$, 95% CI 2.3 to 13, $P<0.0001$). Compared with CVT, those in the BVT group were twice as likely to require intervention, but this finding was not statistically significant ($RR=2.0$, 95% CI 0.64 to 7.4, $P=0.30$).

DISCUSSION

Radiocephalic autogenous access was first reported by Brescia et al (9) and remains the gold standard for formation of autogenous hemodialysis access. However, usually less than 30% of patients are candidates for this type of access placement. In the present study, 28% of the patients were candidates for radiocephalic access placement. Dagher et al (10) reported the first series of BVT in 1976. Since that time, multiple studies have reported a wide range of long-term patency results for BVT (4,6,11-24). Gormus et al (25) have shown no significant differences between forearm and upper arm BVT. Literature regarding CVT is sparse (17). Other techniques using the brachial vein (26) or translocated femoral vein (27) have been reported, with acceptable results. However, due to extensive dissection and morbidity, these procedures have not become popular.

One weakness of the single-stage procedure is that a small basilic vein can easily twist during tunnelling and cause immediate thrombosis or stenosis in the vein near the axillary and basilic junction (swing point). By performing a two-stage transposition, the vein is allowed to mature in situ, resulting in improved success of the BVT. The veins usually increased in size by 72% in four to six weeks after performing the first stage. This was documented with follow-up duplex ultrasound.

Bruns and Jennings (28) described a novel approach of using the median antebrachial vein and proximal radial artery in a side-to-side fashion to create a fistula. Retrograde flow was established in the forearm by disrupting the first valve in the

TABLE 3
One-year secondary patency rates*

Group	Fistula	Kaplan-Meier survival estimates $\pm$ SE			
	Success/ Failure, n	3 months	6 months	9 months	12 months
MPRAVF (n=98)	87/11	0.90 $\pm$ 0.03	0.90 $\pm$ 0.03	0.90 $\pm$ 0.03	0.90 $\pm$ 0.03
BVT (n=87)	77/10	0.99 $\pm$ 0.01	0.95 $\pm$ 0.02	0.92 $\pm$ 0.03	0.90 $\pm$ 0.03
CVT (n=34)	28/6	0.91 $\pm$ 0.05	0.88 $\pm$ 0.06	0.85 $\pm$ 0.06	0.82 $\pm$ 0.06

*Log-rank test for differences in patency among groups, $P=0.61$. BVT Basilic vein transposition; CVT Cephalic vein transposition; MPRAVF Modified proximal radial artery arteriovenous fistula; SE Standard error

TABLE 4
Literature review of basilic vein transposition (BVT)

Author (reference)	Year published	Transpositions, n	Secondary patency (1-year), %
Murphy et al (19)	2000	74	73
Oliver et al (12)	2001	59	64
Ascher et al (32)	2001	63	Not reported
Tsai et al (33)	2002	54	96
Taghizadeh et al (23)	2003	75	66
Segal et al (20)	2003	99	Not reported
Hossny (15)	2003	70	84–90
Lee et al (24)	2004	20	Not reported
Rao et al (18)	2004	56	47
Hill et al (34)	2005	32	Not reported
Keuter et al (13)	2005	31	90
Wolford et al (22)	2005	100	47
Weale et al (35)	2007	71	54
Hashemi et al (present study)	2009	BVT 87 CVT 34	90 82

CVT Cephalic vein transposition

antebrachial vein. In most cases, the cubital basilic vein was ligated. Bruns and Jennings have reported 80% cumulative patency in 71 patients after 42 months.

In our experience with Bruns and Jennings' technique, the fistulas remained patent, but there was significant swelling of the forearm. In addition, the dialysis nurses had difficulty accessing the fistula due to unconventional direction of flow in the forearm veins (cephalad to caudad). Therefore, the primary author decided to modify this technique by performing an end-to-side anastomosis without ligating the cubital basilic vein. This technique allows both basilic and cephalic veins to mature. As a result, 45% (98 of 219) required no further procedures because their cephalic veins were superficial and could be used without any transposition. The remaining patients underwent either a CVT or BVT.

One advantage of MPRAVF is its ability to allow simultaneous maturation of both cephalic and basilic veins. In many cases, if the first transposition fails, then a second vein will be available for transposition. Another advantage of MPRAVF is reduction in frequency of steal syndrome because the flow through the ulnar artery is not disturbed (28). Occasionally, there are disadvantages. In the present series, three female diabetic BVT patients needed to have their cubital cephalic veins ligated because the radial artery could not support adequate flow through both cephalic and basilic veins.

TABLE 5
One-year follow-up with primary, assisted primary and secondary patency

	MPRAVF (n=219)*	BVT (n=87)	CVT (n=34)
Primary patency [†]	98/98 (100) [‡]	83/87 (95)	31/34 (91)
Assisted primary patency [§]	91/98 (93)	60/87 (69)	26/34 (76)
Secondary patency	92/98 (94)	77/87 (89)	28/34 (82)
Interventions [¶]	7/98 (7)	23/83 (28)	5/31 (16)

Data presented as n/n (%). *In this group, 12 arteriovenous fistulas thrombosed, but were redone and remained patent; [†]Modified proximal radial artery arteriovenous fistula (MPRAVF) versus basilic vein transposition (BVT) ($P=0.047$), MPRAVF versus cephalic vein transposition (CVT) ($P=0.02$); [‡]98 patients in the MPRAVF group did not require transpositions; [§]MPRAVF versus BVT ($P<0.001$), MPRAVF versus CVT ($P=0.02$); [¶]MPRAVF versus BVT ($P=0.0002$)

Overall, we believe the advantages outweigh the disadvantages. Even if ligation of the cubital cephalic vein is required, the cephalic vein has already matured and will remain patent. The ligation procedure is very simple and can be well tolerated under light sedation. Finally, all anastomoses were performed using monofilament absorbable sutures. This has been shown to significantly reduce the inflammatory and foreign body reaction at the site of anastomosis, possibly improving patency of the fistula (29).

The majority of interventions for BVTs were due to stenosis at the 'swing point', where the basilic vein joins the axillary vein. Almost all were treated with open-patch angioplasty. We attributed this stenosis to tension on the vein, partial twisting of the vein during tunnelling, or whether the angle between the basilic and axillary veins is too acute, resulting in a significant change in the flow dynamics. Therefore, during the procedure the axillary area was thoroughly dissected out to avoid any tension or encroachment on the vein.

In patients in whom both cephalic and basilic veins had similar diameters, the basilic veins were preferentially transposed because there were more BVT procedures described in the literature. Our data demonstrated no significant differences in one-year secondary patency between the two transposition groups, although there was a trend toward fewer interventions for CVT. Therefore, we currently perform more CVTs, especially in obese patients. The procedure is shorter, less involved, less morbid and eliminates the 'swing point'. With CVT, the vein can also be positioned more anteriorly in the arm, making access easier for the dialysis nurses.

Use of prophylactic antibiotics has not been strongly recommended for cutaneous or superficial tissue procedures (30). No patient undergoing primary fistula construction or transposition received prophylactic antibiotics, and there were no cases of infection in radiocephalic and CVT patients. Three BVT patients and two MPRAVF patients developed wound breakdown. All were female, obese and diabetic, but none had gross infection. All wounds healed with debridement and local care. All the patients who underwent revision with a prosthetic patch received prophylactic antibiotics and none developed any infection.

One radiocephalic patient and two MPRAVF patients developed steal syndrome, requiring ligation of the fistulas. Three BVT patients developed steal syndrome and all three underwent distal revascularization and interval ligation

procedures with complete resolution of their symptoms. These patients had anastomoses to the brachial artery instead of the proximal radial artery. All six patients with steal syndrome were diabetic and five were women.

Preoperative vein mapping with ultrasound was mandatory in all patients, as has been recommended by others (31). Selective venograms were performed in patients who had multiple previous grafts or central venous catheters because the evaluation of the central veins could not be accurately performed with ultrasound. This allowed appropriate selection of the extremity and procedure, resulting in the best outcome. In a subset of the patients, the routine venogram had been performed by interventional nephrologists before the patients visited our service.

Four to six weeks post-transposition, all patients underwent duplex ultrasound examination. If any abnormality was detected, a fistulogram was performed and if any stenosis was present, patients were treated either with balloon or open angioplasty. Open-patch angioplasty was the preferred intervention for anatomical abnormalities, such as a partial twist in the vein that usually occurs near the 'swing point'. Focal stenosis in the body of the vein, if present, often indicates a

sclerotic valve or a stenosis at the site of a previous intravenous cannulation. In these cases, balloon angioplasty was performed. If the result was not satisfactory, then open angioplasty was performed.

A patient's access could be used once the final physical examination and ultrasound were normal. No other routine follow-up ultrasound or physical examination was performed. Recently, we have instituted routine yearly follow-up examination of all the patients who have undergone an access procedure. If clinically indicated, an ultrasound is performed to identify a potential failing access.

CONCLUSION

On the basis of these results, we recommend first creating a radiocephalic fistula. If not possible, then a MPRAVF should be constructed. Finally, if the cephalic vein is not superficial enough for use, either CVT or BVT should be performed. By following this algorithm, we have been able to improve markedly on the patency rate goals recommended by the Fistula First and Kidney Disease Outcomes Quality Initiative guidelines (www.kidney.org/professionals/KDOQI).

REFERENCES

- Fan PY, Schwab SJ. Vascular access: Concepts for the 1990s. *J Am Soc Nephrol* 1992;21:457-71.
- Feldman HI, Korbin S, Wassenstein A. Hemodialysis vascular access morbidity. *J Am Soc Nephrol* 1996;7:523-35.
- Besarab A, Escobar F. A glimmer of hope: Increasing the construction and maturation of autologous arteriovenous fistulas. *Am J Kidney Dis* 1999;33:977-9.
- Churchill DN, Taylor DW, Cook RJ, et al. Canadian hemodialysis morbidity study. *Am J Kidney Dis* 1992;19:214-34.
- Dagher FJ. Upper arm arteriovenous fistula for chronic hemodialysis: 20 years later. *Transplant Proc* 1996;28:2325-7.
- El Sayed HF, Mendoza B, Meier GH, et al. Utility of basilic vein transposition for dialysis access. *Vascular* 2005;13:268-74.
- Sidawy AN, Gray R, Besarab A, et al. Recommended standards for reports dealing with arteriovenous hemodialysis access. *J Vasc Surg* 2002;35:603-10.
- Schuman E, Standage BA, Ragsdale JW, Heintz P. Achieving vascular access success in the quality outcomes era. *Am J Surg* 2002;187:585-9.
- Brescia MJ, Cimino JE, Appel K, Hurwicz BJ. Chronic hemodialysis using venipuncture and a surgically created arteriovenous fistula. *N Engl J Med* 1966;275:1089-92.
- Dagher FJ, Gelber R, Ramos E, Sadler J. The use of basilic vein and brachial artery as an AV fistula for long-term hemodialysis. *J Surg Res* 1976;20:373-6.
- Eknoyan G, Levin NW. Impact of the new K/DOQI guidelines. *Blood Purif* 2002;20:103-8.
- Oliver MJ, McCann RL, Indridason OS, Butterly DW, Schwab SJ. Comparison of transposed brachiocephalic fistulas to upper arm grafts and brachiocephalic fistulas. *Kidney Int* 2001;60:1532-9.
- Keuter XHA, Van der Sande FM, Kessels AG, de Haan MW, Hoeks APG, Tordoir JHM. Excellent performance of one stage brachial-basilic arteriovenous fistula. *Nephrol Dial Transplant* 2005;20:2168-71.
- Murphy GJ, White SA, Knight AJ, Doughman T, Nicholson ML. Long-term results of arteriovenous fistulas using transposed autologous basilic vein. *Br J Surg* 2000;87:819-23.
- Hossny A. Brachiocephalic arteriovenous fistula: Different surgical techniques and their effects on fistula patency and dialysis-related complications. *J Vasc Surg* 2003;37:821-6.
- Humphries AL, Colborn GL, Wynn JJ. Elevated basilic vein arteriovenous fistula. *Am J Surg* 1999;177:489-91.
- Woo K, Farber A, Doros G, Killeen K, Kohanzadeh S. Evaluation of the efficacy of the transposed upper arm arteriovenous fistula: A single institutional review of 190 basilic and cephalic vein transposition procedures. *J Vasc Surg* 2007;46:94-100.
- Rao RK, Azin GD, Hood DB, et al. Basilic vein transposition fistula: A good option for maintaining hemodialysis access site options? *J Vasc Surg* 2004;39:1043-7.
- Murphy GJ, White SA, Knight AJ, Doughman T, Nicholson ML. Long-term results of arteriovenous fistulas using transposed autologous basilic vein. *Brit J Surg* 2000;87:819-23.
- Segal JH, Kayler LK, Henke P, Merion RM, Leavey S, Campbell DA Jr. Vascular access outcomes using the transposed basilic vein arteriovenous fistula. *Am J Kidney Dis* 2003;42:151-7.
- Francis DM, Lu Y, Robertson AJ, Millar RJ, Amy J. Two-stage brachiocephalic arteriovenous fistula for chronic haemodialysis access. *ANZ J Surg* 2007;77:150-5.
- Wolford Hy, Hsu J, Rhodes JM, et al. Outcome after autogenous brachial-basilic upper arm transpositions in the post-National Kidney Foundation Dialysis Outcomes Quality Initiative era. *J Vasc Surg* 2005;42:951-6.
- Taghizadeh A, Dasgupta P, Khan MS, Taylor J, Koffman G. Long-term outcomes of brachiocephalic transposition fistula for haemodialysis. *Eur J Vasc Endovasc Surg* 2003;26:670-2.
- Lee CH, Ko PJ, Liu YH, Hsieh HC, Liu HP. Brachiocephalic fistula as a secondary access procedure: An alternative to a dialysis prosthetic graft. *Chang Gung Med J* 2004;27:816-23.
- Gormus N, Ozerin U, Durgut K, Yuksek T, Solak H. Comparison of autologous basilic vein transpositions between forearm and upper arm regions. *Ann Vasc Surg* 2003;17:522-5.
- Dorobantu LE, Stiru O, Iliescu VA, Novelli E. The brachio-brachial arteriovenous fistula: A new method in patients without a superficial venous system in the upper limb. *J Vasc Access* 2006;7:87-9.
- Huber TS, Hirneise CM, Lee WA, Flynn TC, Seeger JM. Outcome after autogenous brachial-axillary translocated superficial femoropopliteal vein hemodialysis access. *J Vasc Surg* 2004;40:311-8.
- Bruns DB, Jennings WC. Proximal radial artery as inflow site for native arteriovenous fistula. *J Am Coll Surg* 2003;197:58-63.
- Rey AR, Carrillo-Farga J, Velasco CO, Valenica MOV. Use of absorbable sutures in canine carotid arteries. *Tex Heart Inst J* 1990;17:99-102.
- Woods RK, Dellinger EP. Current guidelines for antibiotic prophylaxis of surgical wounds. *Am Fam Physician* 1998;57:2731-42.

31. Parmely MC, Broughan TA, Jennings WC. Vascular ultrasonography prior to dialysis access surgery. *Am J Surg* 2002;184:568-72.
 32. Ascher E, Hingorani A, Gunduz Y, et al. The value and limitations of the arm cephalic and basilic vein for arteriovenous access. *Ann Vasc Surg* 2001;15:89-97.
 33. Tsai YT, Lin SH, Lee GC, Huen GC, Lin YF, Tsai CS. Arteriovenous fistula using transposed basilic vein in chronic hypotensive hemodialysis patients. *Clin Nephrol* 2002;57:376-80.
 34. Hill BB, Chan AK, Faruqi RM, Arko FR, Zarins CK, Fogarty TJ. Keyhole technique for autologous brachiobasilic transposition arteriovenous fistula. *J Vasc Surg* 2005;42:945-50.
 35. Weale AR, Bevis P, Neary WD, Lear PA, Mitchell DC. A comparison between transposed brachiobasilic arteriovenous fistulas and prosthetic brachioaxillary access grafts for vascular access for hemodialysis. *J Vasc Surg* 2007;46:997-1004.
-