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Original Article

Surgery Section

Do Arterial and Venous Diameter Predict the Success of Wrist Radiocephalic Arteriovenous Fistula for Haemodialysis?: A Prospective Interventional Study

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ABSTRACT

Introduction: Native or autogenous Arteriovenous Fistula (AVFs) placed for Chronic Kidney Disease (CKD) is the gold standard. Radiocephalic Arteriovenous Fistula (RCAVF) just proximal to the wrist is preferred, as it provides a larger proximal area for cannulation and can be created using End-to-Side (E-S) and Side-to-Side (S-S) techniques with good patency. Diameters of the radial artery and cephalic vein have been shown to produce predictable results in RCAVF. The distance between the radial artery and the cephalic vein at wrist or even more proximal has not been studied previously and may be instrumental in choosing either of the two surgical techniques for RCAVF.

Aim: To find the optimum diameters of radial artery and cephalic vein, evaluated by Colour Doppler Ultrasound (CDU) that predicted the success of wrist RCAVF in E-S and S-S RCAVF placement techniques for Haemodialysis (HD).

Materials and Methods: This prospective interventional study was carried out in the Departments of Plastic Surgery and Nephrology, Institute of Medical Sciences, Banaras Hindu University, Varanasi, Eastern Uttar Pradesh, India, from January 2019 to June 2021, to study 62 fistula in 52 patients of CKD in whom wrist RCAVF, as vascular access for HD, was constructed. The variables studied were calibre of radial artery and cephalic vein and their bearing on the surgical outcome in E-S and S-S surgical techniques. Further distance between radial artery and cephalic vein (in mm) at the wrist were meticulously studied to find its significance in both E-S and S-S surgical techniques. The outcomes measured were fistula usability (time from AVF placement to fistula maturation and subsequent functional use for HD) and AVF patency three months postoperatively. Significance of comparative variables was studied by two-tailed t-test.

Results: In the present study, average age was 46.86±14.85 years and 37 patients were males while 15 were females. Mean diameter of radial artery was 2.14±0.48 mm while it was 2.12±0.49 mm in E-S and 2.16±0.45 mm in S-S technique (p-value=0.309). Mean diameter of cephalic vein was 2.24±0.64 mm, 2.26±0.67 mm in E-S and 2.22±0.61 mm in S-S technique (p-value=0.734). The distance between the both artery and vein was 5.77±4.06 mm. Thirteen RCF failed to mature (25%), 10 of these underwent secondary surgery for AVF. RCAVF became usable for HD after 7.70±1.12 weeks in E-S group and 7.59±1.19 weeks in S-S group (p-value=0.592). Primary AVF patency was 90.9% in E-S and 92.6% in S-S procedures at three months after surgery when the radial artery and cephalic vein were both larger than 2 mm. If the arteriovenous distance is less than 3 mm, the fistula can be treated using the S-S approach, and if it is greater than 3 mm, the E-S technique.

Conclusion: This study demonstrated association between cephalic vein and Radial Artery Diameter (RAD) (>2 mm) with good three months RCAVF patency. It was shown that the distance between the radial artery and cephalic vein at the wrist serves as a criterion for using either the S-S or E-S surgical procedures.

Keywords: Chronic kidney failure, Colour doppler ultrasound, Forearm, Radial artery, Vascular patency

INTRODUCTION

The successful use of autogenous Arteriovenous Fistula (AVF) among patients with Chronic Kidney Disease (CKD) on Haemodialysis (HD) has obviated the use of central venous catheters or arteriovenous grafts [1]. The native or autogenous Radiocephalic Arteriovenous Fistula (RCAVF) at the level of the wrist is the procedure of choice for vascular access [2]. A surgically well created RCAVF allows flow at >500 mL/min [3]. About 25% of the RCAVF fistulae fail to mature which not only delay the HD but also reduce the number of proximal sites at which another vascular access can be made [4,5]. Juxta-anastomotic stenosis that occurs in the outflow vein within 1-5 cm of the anastomosis has been implicated as the most common cause of AVF failure [6].

Wrist RCAVF has a unique advantage of enabling the use of entire forearm for cannula insertion in patients on HD. It also provides us with more options to create secondary fistula at more proximal sites. The fistula between the radial artery and cephalic vein just proximal to the wrist has been implicated as the procedure of choice and is created with both End to Side (E-S) and Side to Side (S-S) adaptations with good patency and reasonably low complication rates [7]. There are a number of studies with extremely contradictory findings with no unanimous cut-off diameters for radial artery and cephalic vein that could predict primary failure or success [8,9]. However, there has been no research on the arteriovenous distance at the wrist for either of the two fistula placement techniques.

The study was undertaken to test the hypothesis that diameters of the radial artery and cephalic vein, evaluated by CDU, adequately predicted the success or failure of wrist Radiocephalic Fistula (RCF). The parameters were studied for E-S and S-S RCF placement techniques for HD. It was also determined whether arteriovenous distance had the potential to drive the choice of either of the two surgical techniques.

MATERIALS AND METHODS

A prospective interventional study was conducted in the Departments of Plastic Surgery and Nephrology, Institute of Medical Sciences, Banaras Hindu University, Varanasi, Eastern Uttar Pradesh, India, from January 2019 to June 2021. The study was approved by the

Institutional Ethical Committee (Dean/2019/EC/1059) and informed consent was obtained from the study subjects.

A total of 62 fistulae were constructed in 52 patients of CKD who required RCF to provide vascular access for HD. They were enrolled by purposive sampling. The feasibility of placement of radiocephalic AVF just proximal to the wrist, preferably in the non dominant forearm, was decisive in selecting the samples. "Feasibility" refers to vascular, especially venous, characteristics resulting in a simple and easy fistula creation.

Inclusion criteria: Patients of all ages and both genders with CKD, patients with well palpable radial artery in the non dominant upper limb and patients with visible, palpable and compressible veins proximal to the wrist were included in the study.

Exclusion criteria: Patients with prior fistula placement at or proximal to the radiocephalic zone in the proposed upper limb, venepuncture of the cephalic vein within three weeks, patients with Haemoglobin (Hb) <8 gm/dL owing to significantly high risk of primary AVF failure were excluded from the study. Patients with uncontrolled Diabetes Mellitus (DM) or hypertension despite medications, patients with atherosclerosis of vessels demonstrated by CDU, severely ill patients who were likely to be lost in follow-up and patients with evidence of ipsilateral arm trauma or surgery were excluded from the study.

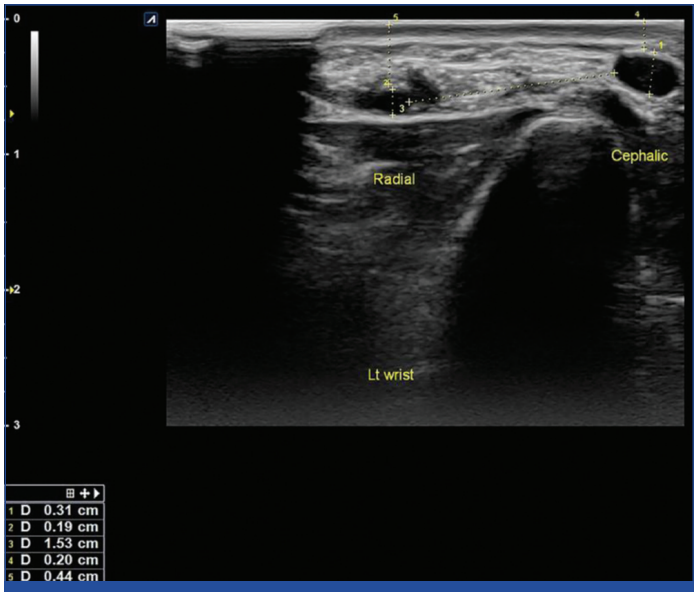
Study Procedure

Anticoagulants, if any, were discontinued a week prior to surgery. Meticulous evaluation of the arterial system was performed by palpation of radial and ulnar peripheral pulses as well as Allen's test in the proposed hand [10]. The venous adequacy was clinically evaluated by refilling of the visible cephalic vein following distal to proximal emptying. The venous course was palpated for firmness secondary to phlebitis.

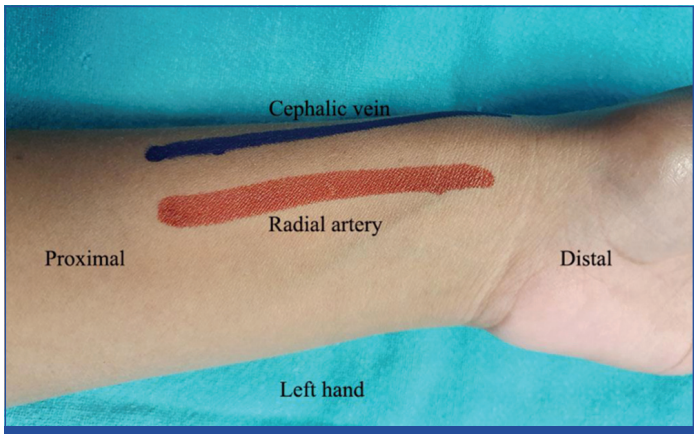
Preoperative CDU (EPIQ Elite, Royal Philips Electronic Inc, Amsterdam, Netherlands) of upper limb arteries and veins was performed in all patients to ascertain the calibre of vessels, distance between the radial artery and cephalic vein at wrist, depth from the skin surface and any atherosclerosis [Table/Fig-1].

Surgical details: Radial artery and cephalic vein were marked prior to surgery [Table/Fig-2] which was performed under local anaesthesia using 2% lignocaine without adrenaline and under magnification. A 4-5 cm longitudinal incision was given on the radial aspect of wrist starting from the styloid process of radius and going proximal. Cephalic vein was identified posterior to the styloid process and radial artery was identified anterior to it. They were mobilised adequately ligating the branches and tributaries predominantly found on the under surface of the vessels [Table/Fig-3]. In the E-S technique of wrist RCAVF, the cephalic vein is divided and 6-7 mm long arteriotomy was used for E-S anastomosis [7,11]. Care taken to prevent venous end perpendicular to the artery, the preferred angle being 60° [Table/Fig-4]. When the venous diameter was less and the cephalic vein was found 4-5 mm in the vicinity of the radial artery, S-S anastomosis was usually preferred. In this technique arteriotomy and venotomy of 8-10 mm was considered sufficient for a good flow. The cephalic vein distal to the anastomosis was ligated to prevent distal run off [Table/Fig-5] and divert arterial blood into the vein in the proximal direction only. Following removal of vascular clamps thrill was felt and bruit was heard and, thus, on table functioning of RCAVF was confirmed. Absence of bruit despite good venous filling and dilatation was indicated impending thrombosis and was managed by subcutaneous low molecular weight heparin. The patients were followed-up on postoperative days 1, 7 and 15 days with reference to thrill and/or bruit that directly indicated primary patency of fistula. Primary outcome assessed was the primary patency of the RCAVF with different diameters of cephalic vein and radial artery. Secondary outcome assessed was the usability of RCAVF for HD in both E-S and S-S groups. Primary patency was defined as the interval from the time of radiocephalic access placement until any intervention designed to maintain or re-establish patency, access thrombosis, or the time of measurement of patency.

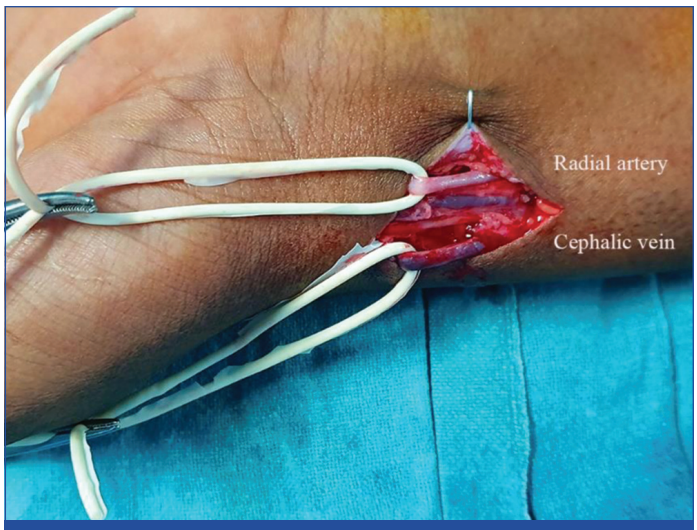
HD was performed (Nipro Surdial 55 plus, Osaka, Japan) using dialysate consisting of bicarbonate and concentrate in 4:3. A dialysate



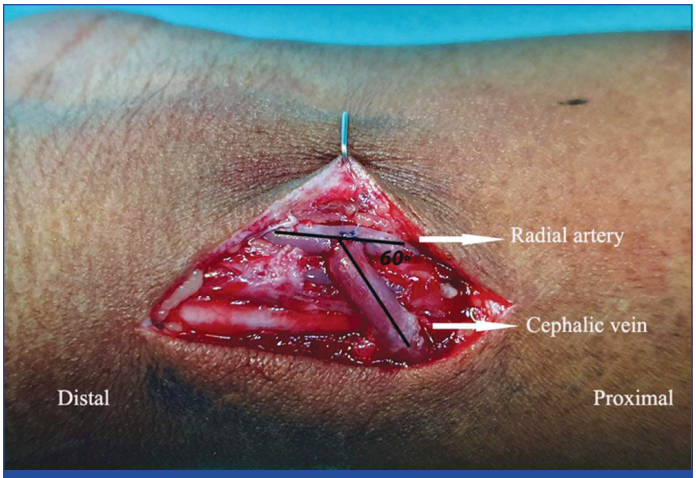
[Table/Fig-1]: Colour Doppler Ultrasound (CDU) (in grayscale) of the left wrist showing numbering in the left bottom corner of the high definition image:
1. Cephalic vein diameter 3.1 mm
2. Radial artery diameter 1.9 mm
3. Distance between vein and artery 15.3 mm
4. Depth of cephalic vein from skin surface 2.0 mm
5. Depth of radial artery from skin surface 4.4 mm



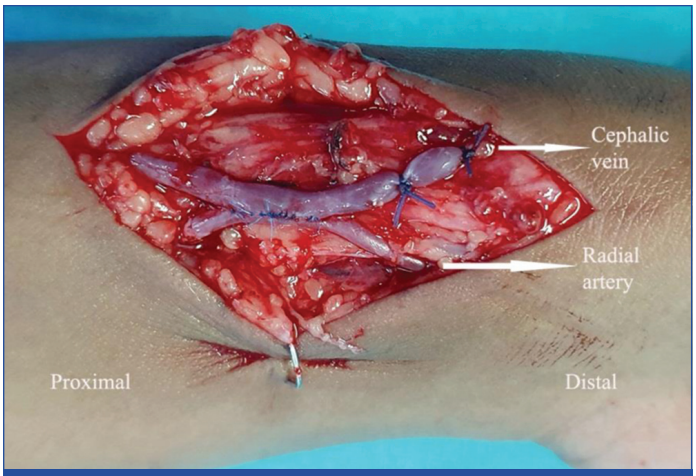
[Table/Fig-2]: Preoperative markings of palpable radial artery (red) and visible compressible cephalic vein (blue).



[Table/Fig-3]: Intraoperative mobilisation of the radial artery and cephalic vein.



[Table/Fig-4]: End to side (E-S) anastomosis with the end of cephalic vein at an angle of about 60° to the radial artery.



[Table/Fig-5]: Side to side (S-S) anastomosis with vein distal to the anastomosis ligated.

flow of 300 mL/min sustained for a minimum of three hours during HD was labelled as good flow. However, the "Rule of 6s" states that six weeks after the AV fistula has been placed, the fistula should be able to support a blood flow of 600 mL/min, be at a maximum of 6 mm from the surface and have a diameter greater than 6 mm [12].

STATISTICAL ANALYSIS

Mean, standard deviation, minimum and maximum values were used for the interpretation of the quantitative variables. However, extremes of minimum or maximum values affected the mean and range. Such variables were assessed by median and Interquartile Range (IQR). A 95% Confidence Interval (95% CI) was calculated wherever applicable. The significance of comparative variables was subject to two-tailed t-test and p-value was calculated.

RESULTS

Mean age of the 52 patients was 46.86±14.85 years (16-75 years) [Table/Fig-6]. The ratio of the number of males to females was 37:15. Patients were found to be suffering from CKD for a median of 24 months. The average creatinine at the time of fistula placement was 5.55±1.16 mg/dL.

Age (years)	≤40	41-60	>60	Total
Average age (years)	28.82	55.57	65.28	46.86±14.85
Range	-	-	-	16-75
Median age (years)	-	-	-	50
IQR (y)	-	-	-	37.5-59
No. of patients	17 (32.69%)	28 (53.85%)	7 (13.46%)	52
Gender				
Males	8	22	7	37 (71.15%)
Females	9	6	0	15 (28.85%)
Hypertension	12/17	25/28	7/7	44 (84.61%)
Diabetes Mellitus	5/17	18/28	6/7	29 (55.77%)
Smoking	-	6/9	3/9	9 (17.31%)
Alcoholic	-	-	2/2	2 (3.85%)
CKD duration (months)	24.82	41.27	85.71	41.52
Range (months)	-	-	-	2-180
Median (months)	-	-	-	24
Mode (months)	-	-	-	24
IQR (months)	-	-	-	12-60
Haemoglobin				
Mean haemoglobin (gm/dL)	9.24	9.10	8.67	9.12
Range	-	-	-	8-11
Mode (gm/dL)	-	-	-	9
≤9 gm/dL	-	-	-	32 (61.54%)
>9 gm/dL				20 (38.46%)

[Table/Fig-6]: Detailed demographic data of the 52 patients.
Results were presented as n, n (%), mean±SD, range and median

E-S fistula was constructed in 24 patients and S-S in 28 patients. The procedure of choice largely depended on the distance between radial artery and cephalic vein [Table/Fig-1].

Mean Hb at the time of fistula placement was 9.12±0.88 gm/dL (range 8-11 gm/dL). A total of 32 patients had Hb 8-9 gm/dL (61.54%) and 20 patients had Hb >9 gm/dL (95% CI, 8.8508 to 9.3292, t=0.703, p-value=0.964).

The lesser the distance the more inclined the surgeons were to perform S-S AVF. Average distance of all 52 patients was 5.77±4.06 mm (95% CI 107 to 8.035). The distance between radial artery and cephalic vein was 8.95 mm (4-16 mm) for E-S and 2.85 (1.4-5 mm) for S-S [Table/Fig-7].

Surgical procedure	End to Side	Side to Side	p-value	Overall
Number	24	28	-	52
Cephalic vein diameter (mm)	2.26±0.67	2.22±0.61	0.734	2.24±0.64
Radial artery diameter (mm)	2.12±0.49	2.16±0.45	0.309	2.14±0.48
Radiocephalic distance (mm)	9.19±3.54 (4-16)	2.85±1.15 (1.4-5)	-	5.77±4.06 (1.4-16)
Mediana	8.95	2.85	-	4.25
Thrill	12/24(50%)	22/28 (78.57%)	-	34/52
Bruit	19/24 (79.16%)	25/28 (89.28%)	-	44/52
Primary maturation (weeks)	7.70±1.12	7.59±1.09	0.592	7.70±1.13
Number of dialysis	62.05±8.80	63.5±9.48	-	63.47 ±9.05
Success after primary surgery/ patency	17 (70.83%)	22 (78.57%)	-	39 (75 %)
Complications	7 thrombosis	6 thrombosis	-	13
Ancillary procedures	5	5	-	10/13
	Mid forearm AVF (4)	BCF (4)	-	(3 did not come for follow-up
	BCF[b] (1)	BVT[c] (1)	-	-

[Table/Fig-7]: Perioperative details of patients.
[a]Extremes of minimum and maximum values of radiocephalic distance in E-S anastomosis is well assessed by median; [b]Brachio-cephalic fistula; [c]Basilic vein transposition

The median venous diameter was 2.4 mm for the entire study sample (2.3 mm for E-S and 2.4 mm for S-S). Primary RCAVF patency ranged from 84.21% with a cephalic vein diameter of 2-2.4 mm to 91.66% with a cephalic vein diameter of 2.5 or greater. RAD was extensively studied and clearly found primary patency with diameter more than 2mm in 94.87% of patients (37 of 39 patients) [Table/Fig-8].

Cephalic vein diameter on Colour Doppler Ultrasound (CDU) and patency of RCAVF						
	E-S		S-S		Total	
Diameter	No of patients (n=24)	Patency n (%)	No of patients (n=28)	Patency n (%)	No of patients (n=52)	Patency n (%)
<2 mm	4	0	5	1 (20%)	9	1 (11%)
2-2.4 mm	10	8 (80%)	9	8 (88.89%)	19	16 (84.21%)
≥2.5 mm	10	9 (90%)	14	13 (92.85%)	24	22 (91.66%)
Radial artery diameter on Colour Doppler Ultrasound (CDU) and patency of RCAVF						
<2 mm	7	1 (14.28%)	6	1 (16.66%)	13	2 (15.38%)
2-2.4 mm	15	14 (93.33%)	19	18 (94.73%)	34	32 (94.12%)
≥2.5 mm	2	2 (100%)	3	3 (100%)	5	5 (100%)

[Table/Fig-8]: Caliber of radial artery and cephalic vein in 52 patients where RCAVF was created by E-S and S-S surgical techniques.

The data collected was of 49 subjects as three of them were lost in follow-up. Thirteen RCF failed to mature (25%), out of these secondary procedures were performed in 10 patients within a median of five days after AVF using vessels of larger diameter. Time taken by fistula to mature and become usable was an important parameter to ascertain fistula success. The usability of AVF for HD in E-S group of patients was after 7.70±1.12 weeks while in S-S group after 7.59±1.19 weeks (p-value=0.592). The data suggested that three months primary patency of RCAVF including secondary procedures (proximal fistula at the elbow or the arm for failed RCAVF) was 90.9% in E-S and 92.6% in S-S techniques.

DISCUSSION

International guidelines rigorously recommend AVF placement because its use is associated with lower mortality as well as avoids the risk of catheter-related complications [12,13]. It has been emphasised that the radiocephalic fistula is the vascular access of preference followed by more proximal fistula and synthetic graft [14]. On the contrary, studies show that survival of RCF was poorer than BCF [15].

There are numerous studies that have analysed age as a covariate of access survival but have largely been inconclusive. In a retrospective review, Thant KZ et al., found that the average age of 246 patients whose AVF was usable six months after AVF placement was 58.3±12.4 years (range 18-87 years). Such a wide age range suggested that other factors besides age may also contribute to the success of AVF [16]. Ocak G et al., also concluded that increased age, female sex and diabetes mellitus were associated with primary patency loss in patients with a fistula [17]. Arhuidese IJ et al., in his study on HD patients found that diabetes mellitus was associated with a decrease in patient survival, access maturation, and primary fistula patency [18]. In the present study, RCF failed in 13 patients (25%) and the average age in failures was 49.69 years (one patient more than 65 years), only four subjects were females and nine were diabetic. A combination of all three was not established in any of the patients. The results were in accordance with the study of Manne V et al., which showed that age, sex, diabetes, and type of construction (E-S or S-S) had no influence over fistula patency rates [19]. As a matter of fact, hypertension was associated with more failures (11 out of 13 patients). Overall prevalence of hypertension in the present study was 84.61% which was in accordance with the study of Ku E et al., who described prevalence of 60-90% [20]. In simple terms, it has been postulated that sustained hypertension constricted the blood vessels damaging and weakening them throughout the body including in the kidneys.

Monroy-Cuadros M et al., in their study suggest smoking as a strong risk factor for AVF failure, but authors could not attribute primary failure to smoking or alcohol in the present study [21]. Abreu R et al., studied 117 patients and found the risk of primary AVF failure in patients with Hb <11 gm/dL [22]. Although the average Hb was 9.12±0.88 gm/dL (range 8-11 gm/dL) in the current study, primary failure of RCAVF was observed in patients with Hb 8.78± 0.47 gm/dL (range 8-9.8 gm/dL).

The calibre of radial artery and cephalic vein has important bearing on AVF success, usability and long term survival. A thorough preoperative evaluation of the vessels of RCAVF was essential to predict its maturation [23]. Most of the studies were aimed at direct assessment of venous diameter in determining fistula outcome [Table/Fig-9] [3,4,8,9,23-26]. Vein diameter was found to be an independent predictor of maturation [8]. Kordzadeh A et al., came up with a novel measurement technique of Arteriovenous Ratio (AVR) index obtained from inflow RAD to that of outflow (cephalic vein diameter). They suggested that AVR index is an independent predictor of functional maturity in RCAVFs and AVR of 1-1.06 results in maturity [24]. Wilmink T and Houlihan MC in their research, concluded that despite the venous diameter of 2 mm at the wrist being a good guide to proceed with RCAVF but AVF formation in smaller vessels was not automatically precluded [25]. Kordzadeh A et al., exhaustively studied 324 patients of RCAVF and suugested that cephalic vein diameter >1.55 mm predicted primary functional maturity [9]. Another study found failure of RCAVF in cephalic vein diameter <3 mm [26]. Recent studies demonstrated successful functional

Author, year and country (reference)	Type of study	Number of patients/ studies	Number of RCAVF	Age (years)	Measured vein parameter	Vein diameter (mm)	Artery diameter (mm)	Outcomes
Bashar K et al., 2015 Ireland [8]	Best evidence topic	5 studies	-	-	Mean venous diameter	≥2.5	NS	Primary outcome was **fistula maturation**: cannulated with two needles and allowed flow of ≥350 mL/min in at least six sessions in one month.
Kordzadeh A et al., 2017 UK [9]	Prospective cohort	548 vascular access procedures	324 (244 males and 80 females)	65	Cephalic vein diameter	>1.55	>1.65	**Primary functional maturity (FM)** The overall primary FM against set standards occurred in 214 (66%) individuals who underwent RCAVF. A cephalic vein diameter of 1.55 mm and radial artery diameter of 1.65 mm were found to be the cut-off values obtained through the corresponding points of the ROC curve.
Voorzaat BM et al., 2018 Netherlands [4]	Original Scientific Report	1383 patients	663 (463 males and 200 females)	62.6± 15.3	Cephalic vein diameter	≥2.5	NS	Primary outcomes assessed were **Access maturation** The incidence of nonmaturation was 24% for RCAVFs. Predictors for nonmaturation were female gender, peripheral vascular disease, cerebrovascular disease and a cephalic vein diameter <2.5 mm.
Kordzadeh A et al., 2018 UK [24]	Single-center prospective cohort Study	324 patients	324	65	*AVR	1-1.06		Novel measurement technique (AVR) is an inde-pendent predictor of functional maturity (FM) in RCAVFs. AVR, 1-1.06, is crucial for optimal haemodynamics of RACVFs and their primary FM.

Wilmink T and Houlihan MC 2018 UK [25]	Retrospective analysis	803 operations	507 (429 males and 178 females)	-	Cephalic vein diameter	At least 2 mm	At least 2 mm	**Primary Outcome- FDU (First Dialysis Use)** Arterial diameter has limited value for predicting functional dialysis use of RCAVF. Artery and vein diameter of 2 mm at the wrist are a reasonable guide to proceed with a forearm AVF but should not automatically preclude AVF formation in smaller vessels.
Misskey J et al., 2020 Canada [26]	Retrospective	356 patients	202	63.8	MVOD	≥3.0	≥2.1	Primary outcomes assessed were **Access maturation and Access patency** For all radiocephalic accesses, maturation failure at 12 months and 36 months was significantly higher for accesses with MVOD <3.0 mm vs MVOD ≥3.0 mm Maturation failure was also significantly higher for accesses with radial artery diameter <2.1 mm vs ≥2.1 mm at 12 months and 36 months MVOD <3.0 mm was associated with reduced primary patency while radial artery diameter was not.
Bhuwania S et al., 2021 India [23]	Prospective observational study	91 patients	91 (49 males and 42 females)	46.04± 16.57 (mature fistula)	Cephalic vein diameter	≥2.0	≥2.0	The primary failure rate of RCAVF was 45.1% at six weeks postsurgery. DUS was also done in all cases to check for maturation of draining vein, blood flow, and its ability to sustain blood flow during Haemodialysis (HD).
Sadasivan K et al., 2021 India [3]	Original article	55 patients	55 (35 males and 20 females)	46.49± 13.98	Cephalic vein diameter	>2.0	NC	While, age and sex of the patient were not important factors, a smaller cephalic vein and atherosclerosis were associated with a poor outcome.
Current study, 2019-2021,	Original article	52 patients was	52 (35 males and 17	46.86± 14.85	Cephalic vein diameter	≥2.0	≥2.0	Radial artery and cephalic vein diameter more than 2 mm resulted in high primary patency of RCAVF. The fistula can be managed by S-S technique if the arteriovenous distance ≤3 mm and by E-S technique if the distance >3 mm.

[Table/Fig-9]: Published studies and comparison with the current study [3,4,8,9,23-26].
NS: Not significant; *AVR: index obtained from inflow (radial artery diameter) to that of outflow (cephalic vein diameter); MVOD: Minimum venous outflow diameter; NC: Not commented

maturation beyond cephalic vein diameter of 2 mm or 2.2 mm [23,27].

Arterial diameters have limited value in predicting dialysis use in forearm fistula [25]. The patency with regard to RAD was studied by Kordzadeh A et al., who found that the optimal range of radial artery for maturation and primary patency of RCAVF was at least 2 mm and never below 1.5 mm [9]. RCAVF maturation failure was found when RAD was <2.1 mm, while in recent study, assessment of RAD demonstrated successful maturation in >90% of patients with diameter more than 2 mm [26,27]. RAD was extensively studied in the present research and clearly found primary patency with diameter more than 2 mm in 94.87% of patients (37 of 39 patients). The findings underline the fact that successful outcome can be achieved by good surgical technique even with such smaller diameter radial artery and cephalic vein.

The depth of vessels from the skin surface was studied by a few researchers and cephalic vein was found to be at 6 mm or less from the surface [28]. Various other parameters have been described in literature but the distance between radial artery and cephalic vein at the wrist have not been described. This distance might have the potential to decide upon the preferred surgical procedure. Authors, in their surgical practice found that with less distance it was more feasible to perform S-S AVF. This was preferred due to minimum mobilisation and ease of placement of RCAVF. Greater arterio-venous distance was not amenable to S-S AVF and therefore E-S AVF was the procedure of choice.

It is worth mentioning that future work can be directed towards comparison of native AVF with Polytetrafluoroethylene (PTFE) grafts. This would establish the superiority of either of the surgical technique. The sample size should also be higher to reach a definite conclusion.

Limitation(s)

This is a single-centred cohort and, therefore, demography of only one region has been studied. It also lacks comparison with other more proximal sites of placement of AVF. Multicentric study could give regional variations and help us to evaluate the surgical techniques and related results better.

CONCLUSION(S)

Primary patency and usability of RCAVF was good when either E-S or S-S techniques were performed. Radial artery and cephalic vein diameter more than 2 mm is recommended to have good primary patency of RCAVF. Arteriovenous distance was crucial in RCAVF, using the S-S approach if it was less than 3 mm and the E-S technique if it was greater than 3 mm.

REFERENCES

[1] Bénard V, Pichette M, Lafrance JP, Elftouh N, Pichette V, Laurin LP, et al. Impact of Arteriovenous fistula creation on estimated glomerular filtration rate decline in Predialysis patients. BMC Nephrol. 2019;20(1):420.
[2] Schmidli J, Widmer MK, Basile C, de Donato G, Gallieni M, Gibbons CP, et al. Editor's Choice - Vascular access: 2018 clinical practice guidelines of the European Society for Vascular Surgery (ESVS). Eur J Vasc Endovasc Surg. 2018;55(6):757-818.
[3] Sadasivan K, Kunjuraman U, Murali B, Yadev I, Kochunarayanan A. Factors affecting the patency of radiocephalic arteriovenous fistulas based on clinico-radiological parameters. Cureus 2021;13(3):e13678.
[4] Voorzaat BM, van der Bogt KEA, Janmaat CJ, Schaik Jv, Dekker FW, Rotmans JI, et al. Arteriovenous fistula maturation failure in a large cohort of hemodialysis patients in the Netherlands. World J Surg. 2018;42(6):1895-903.
[5] Schinstock CA, Albright RC, Williams AW, Dillon JJ, Bergstralh EJ, Jenson BM, et al. Outcomes of arteriovenous fistula creation after the fistula first initiative. Clin J Am Soc Nephrol. 2011;6(8):1996-2002.
[6] Pirozzi N, Mancianti N, Scrivano J, Fazzari L, Pirozzi R, Tozzi M. Monitoring the patient following radio-cephalic arteriovenous fistula creation: Current perspectives. Vasc Health Risk Manag. 2021;17:111-21.
[7] Mozaffar M, Fallah M, Lotfollahzadeh S, Sobhiyeh MR, Gholizadeh B, Jabbehdari S, et al. Comparison of efficacy of side to side versus end to side arteriovenous fistulae formation in chronic renal failure as a permanent hemodialysis access. Nephrourol Mon. 2013;5(3):827-30.
[8] Bashar K, Clarke-Moloney M, Burke PE, Kavanagh EG, Walsh SR. The role of venous diameter in predicting arteriovenous fistula maturation: When not to expect an AVF to mature according to pre-operative vein diameter measurements? A best evidence topic. Int J Surg. 2015;15:95-99.
[9] Kordzadeh A, Askari A, Hoff M, Smith V, Panayiotopoulos Y. The impact of patient demographics, anatomy, comorbidities, and peri-operative planning on the primary functional maturation of autogenous radiocephalic arteriovenous fistula. Eur J Vasc Endovasc Surg. 2017;53(5):726-32.
[10] Agarwal T, Agarwal V, Agarwal P, Thakur S, Bobba R, Sharma D. Assessment of collateral hand circulation by modified Allen's test in normal Indian subjects. J Clin Orthop Trauma. 2020;11(4):626-29.
[11] ElKassaby M, Elsayed N, Mosaad A, Soliman M. End-to-side versus side-to-side anastomosis with distal vein ligation for arteriovenous fistula creation. Vascular. 2021;29(5):790-96.
[12] Lok CE, Huber TS, Lee T, Shenoy S, Yevzlin AS, Abreo K, et al. National Kidney Foundation. KDOQI clinical practice guideline for vascular access: 2019 update. Am J Kidney Dis. 2020;75(4 Suppl 2):S1-S164.
[13] Oliver MJ. The science of fistula maturation. J Am Soc Nephrol. 2018;29(11): 2607-09.
[14] Lee T. Fistula first initiative: historical impact on vascular access practice patterns and influence on future vascular access care. Cardiovasc Eng Technol. 2017;8(3):244-54.

[15] Gaur P, Srivastava A, Sureka SK, Kapoor R, Ansari MS, Singh UP. Outcomes of primary arteriovenous fistula for hemodialysis in elderly patients (>65 years) with end stage renal disease: A study on indian population. Indian J Nephrol. 2019;29(6):387-92.
[16] Thant KZ, Quah K, Ng TK, Ho P. Retrospective review of arteriovenous fistula success rate in a multi-ethnic Asian population. J Vasc Access. 2016;17(2):131-37.
[17] Ocak G, Rotmans JI, Vossen CY, Rosendaal FR, Krediet RT, Boeschoten EW, et al. Type of arteriovenous vascular access and association with patency and mortality. BMC Nephrol. 2013;14:79.
[18] Arhuidese IJ, Purohit A, Elemuo C, Parkerson GR, Shames ML, Malas MB. Outcomes of autogenous fistulas and prosthetic grafts for hemodialysis access in diabetic and nondiabetic patients. J Vasc Surg. 2020;72(6):2088-96.
[19] Manne V, Vaddi SP, Reddy VB, Dayapule S. Factors influencing patency of Brescia-Cimino arteriovenous fistulas in hemodialysis patients. Saudi J Kidney Dis Transpl. 2017;28(2):313-17.
[20] Ku E, Lee BJ, Wei J, Weir MR. Hypertension in CKD: Core Curriculum 2019. Am J Kidney Dis. 2019;74(1):120-31.
[21] Monroy-Cuadros M, Yilmaz S, Salazar-Bañuelos A, Doig C. Risk factors associated with patency loss of hemodialysis vascular access within 6 months. Clin J Am Soc Nephrol. 2010;5(10):1787-92.
[22] Abreu R, Rioja S, Vallespin J, Vinuesa X, Iglesias R, Ibeas J. Predictors of early failure and secondary patency in native arteriovenous fistulas for hemodialysis. Int Angiol. 2018;37(4):310-14.
[23] Bhuwania S, Goel R, Bansal R, Saxena S. Prospective evaluation of radiocephalic arteriovenous fistula to determine the causes for non maturity with clinical and ultrasonography-doppler. Indian J Vasc Endovasc Surg. 2021;8:S147-52.
[24] Kordzadeh A, Askari A, Panayiotopoulos Y. Independent association of arteriovenous ratio index on the primary functional maturation of autologous radiocephalic arteriovenous fistula. J Vasc Surg. 2018;67(6):1821-28.
[25] Wilmink T, Houlihan MC. Diameter criteria have limited value for prediction of functional dialysis use of arteriovenous fistulas. Eur J Vasc Endovasc Surg. 2018;56(4):572-81.
[26] Misskey J, Hamidizadeh R, Faulds J, Chen J, Gagnon J, Hsiang Y. Influence of artery and vein diameters on autogenous arteriovenous access patency. J Vasc Surg. 2020;71(1):158-72.
[27] Srivastava A, Sureka SK, Prabhakaran S, Lal H, Ansari MS, Kapoor R. Role of preoperative duplex ultrasonography to predict functional maturation of wrist radiocephalic arteriovenous fistula: a study on Indian population. Indian J Nephrol. 2018;28(1):10-14.
[28] Teodorescu V, Gustavson S, Schanzer H. Duplex ultrasound evaluation of hemodialysis access: A detailed protocol. Int J Nephrol. 2012;2012:508956.

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