

To Study the Comparison of Vascular Access of Brachio basilic Arteriovenous Fistula to Brachiocephalic Arteriovenous Fistula for Hemodialysis in Patients of End Stage Renal Diseases

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ABSTRACT

Hemodialysis remains a life-saving therapy for patients with end-stage renal disease (ESRD), and the development of reliable vascular access has been central to its success. The history of vascular access is marked by several milestones, beginning with the first arterial anastomosis experiments by Jaboulay and Briau in 1896 and subsequent contributions by Alexis Carrel in vascular surgery. These foundational works paved the way for Georg Haas's first human hemodialysis in 1924, Kolff's rotating drum kidney in 1943, Scribner's external AV shunt in 1960, and ultimately Brescia and Cimino's native AV fistula in 1965, which remains the current gold standard.

Objectives: This review aims to trace the historical evolution of vascular access for hemodialysis, highlight key clinical advancements, and summarize current strategies that improve outcomes and patient quality of life.

Methods: A literature-based review was conducted, synthesizing historical records, landmark studies, and recent clinical evidence related to the development, refinement, and optimization of vascular access for hemodialysis. Key topics included surgical innovations, imaging technologies, predictive factors for fistula success, and complication management.

Results: Findings indicate that innovations in surgical methods, such as end-to-side anastomosis and basilic vein transposition, along with technological advances like Doppler ultrasound and duplex sonography, have significantly improved patency rates and reduced complications. Predictive parameters including vessel diameter, blood flow, and arterial elasticity have enhanced preoperative planning and individualized patient care. The "Rule of 6s," maturation criteria, and buttonhole cannulation techniques have provided practical tools for clinicians. Despite ongoing complications such as stenosis, thrombosis, and aneurysm formation, native AV fistulas consistently demonstrate superior longevity and lower morbidity compared to grafts and catheters.

Conclusion: The evolution of vascular access for hemodialysis reflects a continuum of surgical innovation, technological advancement, and multidisciplinary care. While challenges remain, modern approaches emphasizing early evaluation, imaging-guided planning, and personalized techniques have greatly improved vascular access outcomes. Native AV fistulas, supported by these innovations, continue to be the preferred option, offering better survival, reduced complications, and improved quality of life for patients with ESRD.

Keywords: Chronic Kidney Disease, renal disease, Doppler ultrasound, anastomosis.

1: Introduction

Chronic Kidney Disease (CKD) is a progressive disorder that causes irreversible damage to both kidneys. Its global prevalence is high, averaging 11% in the United States and Europe, excluding patients on dialysis or with functioning transplants. Diabetes mellitus is a leading cause of CKD.

The main goal of hemodialysis is to restore fluid and electrolyte balance similar to healthy kidney function [1]. Vascular access is crucial for the effectiveness and outcomes of hemodialysis. Among the various options, the native arteriovenous fistula (AVF) is preferred for its long-term patency, low rates of morbidity, mortality, and infection, along with a reduced need for additional interventions. Despite strong clinical recommendations like those from the National Kidney Foundation's Kidney Disease Outcomes Quality Initiative (NKF-KDOQI), which suggests a native AVF prevalence of at least 65%, many patients—particularly in developing regions—start dialysis with central venous catheters, with only a small percentage beginning with an AVF.

Currently, there are three main types of chronic vascular access: native AVFs, arteriovenous grafts (AVG), and tunneled double-lumen central venous catheters (CVCs). AVFs, usually created as radiocephalic, brachiocephalic, or brachio basilic fistulas, have the best success rates and durability [2]. The side-to-side and end-to-side anastomotic techniques are widely used, with the side-to-side approach seen as technically easier and showing positive patency results. AVGs are used when native vessels are not suitable, providing reliable access but with a slightly higher risk of complications like thrombosis and infection [3]. CVCs offer immediate access but carry the highest risk and are used mainly for urgent or short-term needs. Considering the various anatomical options and complications associated, this study aims to assess the best sites for AVF creation, success rates in different anatomical locations, and the range of complications experienced with arteriovenous fistulas in chronic hemodialysis [4].

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Study Design

Randomized Controlled Trial

Sample Size

Using following values, the sample size was calculated using OPEN EPI software, the total sample size required is 150 patients. Considering 1:1 randomization, each group will have following sample size.

Group A: Patients of ESRD with Brachiobasalic Arteriovenous Fistula; **n=75**

Group B: Patients of ESRD with Brachiocephalic Arteriovenous Fistula; **n = 75**

Formula:

$$1 - \beta = 1 - \text{Probt} \left(t_{1-\alpha/2, n_A(r+1)-2}, n_A(r+1) - 2, \sqrt{\frac{rn_A d^2}{(r+1)\sigma^2}} \right)$$

Desired Power= 95%

Ratio=1

a (Probability of a Type I Error (false positive))=5%

(Common standard deviation)=0.81

d (Difference in means $\mu_2 - \mu_1 = 0.51$ $\delta = 0.62963$

Minimum Sample size required is 134 ($n_1=67, n_2=67$) in each group.

Table 1:- Comparison of age (years) between brachiobasilic and brachiocephalic

Age (years)	Brachiobasilic (n=75)	Brachiocephalic (n=75)	Total	P value
<=20	1 (1.33%)	1 (1.33%)	2 (1.33%)	0.87 [‡]
21-30	8 (10.67%)	9 (12%)	17 (11.33%)	
31-40	13 (17.33%)	19 (25.33%)	32 (21.33%)	
41-50	22 (29.33%)	22 (29.33%)	44 (29.33%)	
51-60	16 (21.33%)	13 (17.33%)	29 (19.33%)	
61-70	9 (12%)	8 (10.67%)	17 (11.33%)	
>70	6 (8%)	3 (4%)	9 (6%)	
Mean±SD	48.89±14.17	45.96±13.34	47.43±13.79	0.194 [*]
Median(25th-75th percentile)	48(40-58)	45(37-52.5)	47(39-55)	
Range	20-78	13-77	13-78	

*Independent ttest, ‡ Fisher's exact test

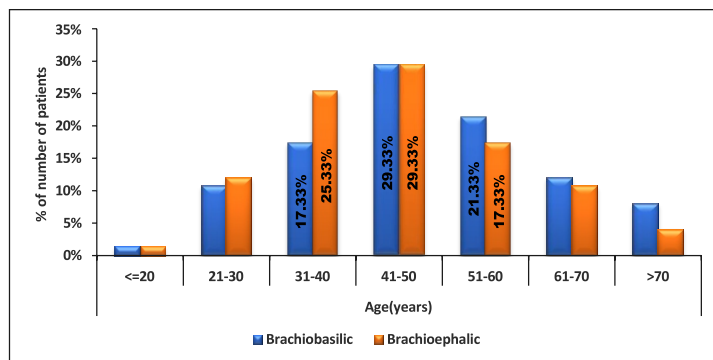


Figure1:-Comparison of age (years) between brachiobasilic and brachiocephalic.

Consider dropout rate

Considering 10% drop out rate.

Group 1 = 75

Group 2 = 75

Considering 10% drop out rate.

Total Sample required is 150 ($n_1 = 75, n_2 = 75$)**Study Population****Inclusion Criteria**

- 1.All the patients with End Stage Renal Disease on Maintenance Hemodialysis (MHD).
- 2.All the patients with End Stage Renal Disease that required MHD as advised by treating Physicians or Nephrologists.
- 3.All the patients with End Stage Renal Disease that required Renal Transplant surgery, but was on Hemodialysis (HD).
- 4.Patients who previously had arteriovenous fistula surgery that failed for any reason, with vascular access created on the opposite upper arm.

Exclusion Criteria

1. Patients with previously operated AVF with complications.
2. Patients with failed arteriovenous fistula on both upper arms

Result

Distribution of age (years) was comparable between brachiobasilic and brachiocephalic. (≤ 20 years:-1.33% vs 1.33% respectively, 21-30 years:-10.67% vs 12% respectively, 31-40 years:- 17.33% vs 25.33% respectively, 41-50 years:-29.33% vs 29.33% respectively, 51-60 years:-21.33% vs 17.33% respectively, 61-70 years:- 12% vs 10.67% respectively, >70 years:-8% vs 4% respectively)(p value=0.87).

Mean±SD of age (years) in brachiobasilic was 48.89±14.17 and brachiocephalic was 45.96±13.34 with no significant difference between them.(p value=0.194

Table 2:-Comparison of gender between brachio basilic and brachiocephalic

Gender	Brachio basilic (n=75)	Brachiocephalic (n=75)	Total	P value
Female	24 (32%)	28 (37.33%)	52 (34.67%)	0.493 [§]
Male	51 (68%)	47 (62.67%)	98 (65.33%)	
Total	75 (100%)	75 (100%)	150 (100%)	

§Chisquare test

Distribution of gender was comparable between brachio basilic and brachiocephalic. (Female:-32% vs 37.33 % respectively, Male:- 68 % vs 62.67% respectively) (p value=0.493). It is shown in table 2

Table 6:- Comparison of co-morbidities between brachio basilic and brachiocephalic

Co-morbidities	Brachio basilic (n=75)	Brachiocephalic (n=75)	Total	Pvalue
Diabetes mellitus	39 (52%)	33 (44%)	72 (48%)	0.327 [§]
Hypertension	35 (46.67%)	50 (66.67%)	85 (56.67%)	0.013 [§]
Atherosclerosis	6 (8%)	3 (4%)	9 (6%)	0.494 [‡]
CVA	3 (4%)	5 (6.67%)	8 (5.33%)	0.719 [‡]
Peripheral arterial disease	44 (58.67%)	42 (56%)	86 (57.33%)	0.741 [§]
Peripheral venous disorder	5 (6.67%)	4 (5.33%)	9 (6%)	1 [‡]
Any other disorder	27 (36%)	35 (46.67%)	62 (41.33%)	0.185 [§]

‡Fisher's exact test, §Chisquare test

Proportion of patients with hypertension was significantly lower in brachio basilic as compared to brachiocephalic (Hypertension:- 46.67% vs 66.67% respectively). (p value=0.013)

Distribution of co-morbidities was comparable between brachio basilic and brachiocephalic. (Diabetes mellitus:- 52 % vs 44 % respectively (p value=0.327), Athero sclerosis:-8 % vs 4 % respectively (p value=0.494), CVA:- 4 % vs 6.67 % respectively (p value=0.719), Peripheral arterial disease:- 58.67 % vs 56 % respectively (p value=0.741), Peripheral venous disorder:- 6.67 % vs 5.33 % respectively (p value=1), Any other disorder:- 36 % vs 46.67 % respectively (p value=0.185). It is shown in table 6

Table 7:- Comparison of forearm inspection between brachio basilic and brachiocephalic

Forearm inspection	Brachio basilic (n=75)	Brachiocephalic (n=75)	Total	P value
Abnormal Condition of skin	4 (5.33%)	7 (9.33%)	11 (7.33%)	0.533 [‡]
Visible veins	37 (49.33%)	35 (46.67%)	72 (48%)	0.744 [§]
Previous Scar marks	5 (6.67%)	4 (5.33%)	9 (6%)	1 [‡]

‡Fisher's exact test, §Chisquare test

Distribution of forearm inspection was comparable between brachio basilic and brachiocephalic. (Abnormal condition of skin:-5.33 % vs 9.33 % respectively (p value=0.533), Visible veins:- 49.33 % vs 46.67 % respectively (p value=0.744), Previous scar marks:- 6.67 % vs 5.33 % respectively (p value=1). It is shown in table 7.

Table 8:-Comparison of upper arm inspection between brachio basilic and brachiocephalic

Upper arm inspection	Brachio basilic (n=75)	Brachiocephalic (n=75)	Total	P value
Abnormal Condition of skin	4 (5.33%)	7 (9.33%)	11 (7.33%)	0.533 [‡]
Visible veins	35 (46.67%)	50 (66.67%)	85 (56.67%)	0.013 [§]
Previous Scar marks	5 (6.67%)	4 (5.33%)	9 (6%)	1 [‡]

‡Fisher's exact test, §Chisquare test

Proportion of patients with visible veins in upper arm was significantly lower in brachio basilic as compared to brachiocephalic (Visible veins:- 46.67 % vs 66.67 % respectively). (p value=0.013)

Distribution of other upper arm inspection was comparable between brachio basilic and brachiocephalic . Abnormal condition of skin:-5.33 % vs 9.33 % respectively (pvalue=0.533), Previous scar marks:- 6.67 % vs 5.33 % respectively (p value=1)). It is shown in table 8.

Table 9:- Comparison of forearm (radial) between brachio basilic and brachiocephalic

Forearm (radial)	Brachio basilic (n=75)	Brachiocephalic (n=75)	Total	P value
Arterial volume				
Low volume	40 (53.33%)	25 (33.33%)	65 (43.33%)	0.013§
High volume	35 (46.67%)	50 (66.67%)	85 (56.67%)	
Condition of vessel wall				
Normal	69 (92%)	72 (96%)	141 (94%)	0.494‡
Atherosclerotic	6 (8%)	3 (4%)	9 (6%)	
Palpation of vein				
Non palpable	38 (50.67%)	40 (53.33%)	78 (52%)	0.744§
Palpable	37 (49.33%)	35 (46.67%)	72 (48%)	

‡Fisher's exact test, §Chisquare test

Proportion of patients with low arterial volume was significantly higher in brachio basilic as compared to brachiocephalic (Low volume:-53.33 % vs 33.33 % respectively). Proportion of patients with high arterial volume was significantly lower in brachio basilic as compared to brachiocephalic (High volume:- 46.67 % vs 66.67% respectively). (p value=0.013) Distribution of condition of vessel wall was comparable between brachio basilic and brachiocephalic. (Normal:- 92 % vs 96 % respectively, Atherosclerotic:-8 % vs 4 % respectively)(p value=0.494). Distribution of palpation of vein was comparable between brachio basilic and brachiocephalic. (Non palpable:- 50.67 % vs 53.33 % respectively, Palpable:- 49.33 % vs 46.67 % respectively) (p value=0.744). It is shown in table 9.

Table 16:- Comparison of pre-operative colour Doppler of upper limb{Brachial artery} between brachio basilic and brachiocephalic

Pre-operative colour Doppler of upper limb{Brachial artery}	Brachioasilic (n=75)	Brachiocephalic (n=75)	Total	P value
Pre-operative color Doppler of upper limb{Brachial artery}				
Atherosclerotic changes	17 (22.67%)	27 (36%)	44 (29.33%)	0.073§
Wall calcification	6 (8%)	3 (4%)	9 (6%)	0.494‡
Tortuosity	4 (5.33%)	7 (9.33%)	11 (7.33%)	0.533‡
Caliber(mm)				
Mean±SD	4.08 ±0.18	4.08 ±0.15	4.08 ±0.16	0.962‡
Median(25th-75th percentile)	4.1(3.9-4.2)	4.1(3.9-4.2)	4.1(3.9-4.2)	
Range	3.7-4.5	3.8-4.3	3.7-4.5	
Vmax(cm/sec)				
Mean±SD	84.19±1.67	83.65±1.57	83.92±1.64	0.056‡
Median(25th-75th percentile)	84(83-85)	84(82-85)	84(83-85)	
Range	80-90	80-87	80-90	
Qmax(mL/min)				
Mean±SD	131.38±48.02	111.67±48.71	121.52±49.2	0.021†
Median(25th-75th percentile)	131.88(101.14-169.63)	103.86(72.17-140.52)	124.54(79.18-149.21)	
Range	28.85-286.12	23.08-286.12	23.08-286.12	
Depth from skin(mm)				
Mean±SD	4.36 ±0.49	4.36 ±0.41	4.36 ±0.45	0.854‡
Median(25th-75th percentile)	4.4(4.2-4.6)	4.4(4.2-4.6)	4.4(4.2-4.6)	
Range	3.2-5.4	3.2-5.4	3.2-5.4	

[‡]Mann Whitney test, [§]Chisquare test, [‡]Fisher's exact test

Distribution of pre-operative colour doppler of upper limb {Brachial artery} was comparable between brachio basilic and brachiocephalic.(Atherosclerotic changes:-22.67%vs 36 % respectively (p value=0.073),Wall calcification:- 8 % vs 4% respectively (p value=0.494), Tortuosity:- 5.33 % vs 9.33 % respectively (p value=0.533)).

No significant difference was seen in caliber (mm) (p value=0.962),V max (cm/sec) (p value= 0.056), depth from skin (mm) (p value=0.854) between brachio basilic and brachiocephalic. Median (25th-75th percentile) of caliber (mm), V max (cm/sec), depth from skin (mm) in brachio basilic was 4.1(3.9-4.2), 84(83-85), 4.4(4.2-4.6) respectively and in brachiocephalic was 4.1(3.9-4.2), 84(82-85), 4.4(4.2-4.6) respectively with no significant difference between them.Significant difference was seen in Q max (mL/min) between brachio basilic and brachiocephalic.(p value <.05) Median(25th-75th percentile) of Q max (mL/min) in brachio basilic was 131.88(101.14-169.63) which was significantly higher as compared to brachiocephalic (103.86(72.17-140.52)(p value=0.021)). It is shown in table 16, figure 16.1 and 16.2.

Table 19:- Comparison of operative details between brachio basilic and brachiocephalic

Operative details	Brachio basilic (n=75)	Brachiocephalic (n=75)	Total	Pvalue
Side				
Left	28 (37.33%)	33 (44%)	61 (40.67%)	0.406§
Right	47 (62.67%)	42 (56%)	89 (59.33%)	
Type of anastomosis				
Side to side	75 (100%)	75 (100%)	150 (100%)	-
Suture material				
Prolene	75 (100%)	75 (100%)	150 (100%)	-
Loops used				
No	71 (94.67%)	68 (90.67%)	139 (92.67%)	0.533‡
Yes	4 (5.33%)	7 (9.33%)	11 (7.33%)	

[‡]Fisher's exact test, [§]Chisquare test

Distribution of side was comparable between brachio basilic and brachiocephalic. (Left:- 37.33 % vs 44 % respectively, right:- 62.67 % vs 56 % respectively) (p value=0.406).

Distribution of loops used was comparable between brachio basilic and brachiocephalic. (No:- 94.67 % vs 90.67 % respectively, Yes:- 5.33 % vs 9.33 % respectively) (p value=0.533).All the patients had side to side anastomosis and prolene suture material was used in all patients. It is shown in table 19

Table 20:- Comparison of intra operative findings between brachio basilic and brachiocephalic

Intra operative findings	Brachio basilic (n=75)	Brachiocephalic (n=75)	Total	Pvalue
Mismatched Diameters of artery and Vein	0 (0%)	0 (0%)	0 (0%)	-
Vascular injury of the mobilized segment	0 (0%)	0 (0%)	0 (0%)	-
Presence of valve in The distal segment	0 (0%)	0 (0%)	0 (0%)	-
More than one Tributary of the vein	0 (0%)	0 (0%)	0 (0%)	-
Peripheral location Of the previous fistula	4 (5.33%)	7 (9.33%)	11 (7.33%)	0.533 [‡]
Atherosclerotic artery	17 (22.67%)	27 (36%)	44 (29.33%)	0.073 [§]
Oedema over the extremity	6 (8%)	3 (4%)	9 (6%)	0.494 [‡]

Duration of prick over the extremity before surgery (days)				
Mean±SD	51.09±6.74	51 ±6.37	51.05±6.53	0.819†
Median(25th-75th percentile)	50(45-56)	51(45-55)	51(45-55)	
Range	40-74	40-62	40-74	
Length of anastomosis (mm)				
Mean±SD	9.06 ±0.66	8.93 ±0.6	8.99 ±0.63	0.203†
Median(25th-75th percentile)	9(8.5-9.6)	8.9(8.5-9.5)	8.95(8.5-9.6)	
Range	7.8-10.2	7.9-10	7.8-10.2	
Diameter of artery(mm)				
Mean±SD	4.29 ±0.42	4.23 ±0.41	4.26 ±0.42	0.386†
Median(25th-75th percentile)	4.3(4.1-4.6)	4.3(3.9-4.6)	4.3(4-4.6)	
percentile)				
Range	2.8-4.9	3.2-4.9	2.8-4.9	
Diameter of vein(mm)				
Mean±SD	2.85 ±0.52	2.92 ±0.52	2.88 ±0.52	0.382†
Median(25th-75 th percentile)	2.8(2.4-3.2)	2.9(2.6-3.4)	2.8(2.45-3.3)	
Range	2.1-3.8	2.1-3.8	2.1-3.8	

[†]Mann Whitney test, [‡]Fisher's exact test, [§]Chisquaretest

Distribution of intra operative findings was comparable between brachio basilic and brachio cephalic. (Peripheral location of the previous fistula:- 5.33% vs 9.33% respectively (p value=0.533), Atherosclerotic artery:- 22.67% vs 36% respectively (p value=0.073), Oedema over the extremity:- 8% vs 4% respectively (p value=0.494)).

None of the patient had mismatched diameters of artery and vein, vascular injury of the mobilized segment, presence of valve in the distal segment, more than one tributary of the vein.

No significant difference was seen in duration of prick over the extremity before surgery (days) (p value=0.819), length of anastomosis (mm)(p value=0.203), diameter of artery (mm) (pvalue=0.386),diameter of vein (mm) (p value=0.382) between brachio basilic and brachio cephalic. Median (25th-75th percentile) of duration of prick over the extremity before surgery (days), length of anastomosis (mm), diameter of artery (mm),diameter of vein (mm) in brachio basilic was 50 (45-56), 9 (8.5-9.6), 4.3 (4.1-4.6), 2.8(2.4-3.2) respectively and in brachio cephalic was 51(45-55), 8.9(8.5-9.5), 4.3(3.9-4.6), 2.9(2.6-3.4) respectively with no significant difference between them.

It is shown in table 20.

Table 21:- Comparison of postoperative radiological assessment between brachio basilic and brachio cephalic

Post operative radiological assessment	Brachio basilic(n=7 5)	Brachio cephalic(n=7 5)	Total	P value
Postoperative radiological assessment				
Aneurysm	0 (0%)	0 (0%)	0 (0%)	-
Subcutaneous collections	5 (6.67%)	2 (2.67%)	7 (4.67%)	0.442 ‡
Post-operative day				
Mean±SD	3 ±0	3 ±0	3 ±0	1 [†]
Median(25th -75th percentile)	3(3-3)	3(3-3)	3(3-3)	
Range	3-3	3-3	3-3	
Caliber(mm)				
Mean±SD	2.68 ±0.48	2.7 ±0.44	2.69 ±0.46	0.696 †
Median(25th -75th percentile)	2.6(2.3-3.05)	2.6(2.4-3.05)	2.6(2.3-3.075)	
Range	2-3.6	2-3.9	2-3.9	
Vmax(cm/sec)				
Mean±SD	137.65±17.93	133.53±15.06	135.59±16.63	0.222 †
Median(25th -75th percentile)	134(120-152)	132(120-144.5)	133.5(120-149.75)	
Range	112-181	106-175	106-181	
Qmax(mL/min)				
Mean±SD	629.58±114.88	646.86±121.62	638.22±118.22	0.366 †
Median(25th -75th percentile)	643.23(564.7-677.385)	653.33(564.55-763.865)	643.23(564.495-732.007)	
Range	399.56-887.76	349.34-887.76	349.34-887.76	

[†]Mann Whitney test, [‡]Fisher's exact test

Distribution of post operative radiological assessment was comparable between brachio basilic and brachio cephalic.(Subcutaneous collections:-6.67 % vs 2.67 % respectively) (p value=0.442).

None of the patient had aneurysm.

No significant difference was seen in post-operative day (p value=1), caliber (mm)(p value=0.696), V max (cm/sec)(p value=0.222), Q max (mL/min)(p value=0.366) between brachio basilic and brachio cephalic. Median(25th-75th percentile) of post-operative day, caliber (mm), V max (cm/sec), Q max (mL/min) in brachio basilic was 3(3-3), 2.6(2.3-3.05), 134 (120-152), 643.23 (564.7-677.385) respectively and in brachio cephalic was 3(3-3),2.6(2.4-3.05), 132 (120-144.5), 653.33 (564.55-763.865) respectively with no significant difference between them.

Table 22:- Comparison of postoperative clinical assessment between brachio basilic and brachiocephalic

Postoperative clinical assessment	Brachio basilic (n=75)	Brachiocephalic (n=75)	Total	Pvalue
Postoperative clinical assessment				
Visible Veins at Elbow and wrist	75 (100%)	72 (96%)	147 (98%)	0.245*
Palpation of distal arteries	73 (97.33%)	73 (97.33%)	146 (97.33%)	1 [‡]
Post-operative day				
Mean±SD	40.25±4.93	39.4 ±4.93	39.83±4.93	0.319†
Median(25th-75th percentile)	40(37-43.5)	39(35.5-43)	40(37-43)	
Range	32-56	30-56	30-56	

*Mann Whitney test, ‡Fisher's exact test

Figure 22.2:- Comparison of post-operative day between brachio basilic and brachiocephalic.(non-parametric variable, Box-whisker plot)

Distribution of post operative clinical assessment was comparable between brachio basilic and brachiocephalic. (Visible Veins at elbow and wrist: - 100% vs 96% respectively (p value=0.245), Palpation of distal arteries:- 97.33% vs 97.33% respectively (p value=1)).

No significant difference was seen in post-operative day (p value=0.319) between brachio basilic and brachiocephalic. Median(25th-75th percentile) post-operative day in brachio basilic was 40(37-43.5) and in brachiocephalic was 39(35.5-43) with no significant difference between them. It is shown in table 22

Table 23:- Comparison of follow up radiological assessment between brachio basilic and brachiocephalic

Follow up radiological assessment	Brachio basilic (n=75)	Brachiocephalic (n=75)	Total	P value
Aneurysm	0 (0%)	0 (0%)	0 (0%)	-
Subcutaneous collections	5 (6.67%)	2 (2.67%)	7 (4.67%)	0.44 2 [‡]
Post-operative day				
Mean±SD	44.81±3.33	44.8 ±2.68	44.81±3.01	0.51 5 [†]
Median(25th-75th percentile)	45(43-47)	45(43-47)	45(43-47)	
Range	35-50	38-50	35-50	
Caliber(mm)				
Mean±SD	4.53 ±0.41	4.57 ±0.37	4.55 ±0.39	0.41 7 [†]
Median(25th-75th percentile)	4.4(4.2-4.85)	4.6(4.2-4.9)	4.6(4.2-4.9)	
Range	3.8-5.5	3.9-5.3	3.8-5.5	
Vmax(cm/sec)				
Mean±SD	252.71±40.49	248.75±39.76	250.73±40.04	0.38 7 [†]
Median(25th-75th percentile)	241(229.5-276)	234(219-284)	238(219-276)	
Range	180-342	180-330	180-342	
Qmax(mL/min)				
Mean±SD	641.74±117.39	646.17±128.53	643.95±122.69	0.81 0 [†]
Median(25th-75th percentile)	624.26(565.2-728.87)	623.98(565.32-735.07)	624.12(565.2-732.31)	
Range	414.34-955.19	395.64-955.19	395.64-955.19	

*Mann Whitney test, ‡Fisher's exact test

None of the patients had aneurysm.

Distribution of Subcutaneous collections was comparable between brachio basilic and brachiocephalic. (Subcutaneous collections:- 6.67% vs 2.67% respectively) (p value=0.442). No significant difference was seen in post-operative day(pvalue=0.515), caliber(mm)(p value=0.417), Vmax (cm/sec) (p value=0.387), Qmax (mL/min) (p value=0.810) between brachio basilica and brachiocephalic. Median (25th-75th percentile) of post-operative day, caliber (mm), Vmax (cm/sec), Qmax (mL/min) in brachio basilic was 45 (43-47), 4.4 (4.2-4.85), 241 (229.5-276), 624.26 (565.2-728.87) respectively and in brachiocephalic was 45 (43-47), 4.6 (4.2-4.9), 234 (219-284), 623.98 (565.32-735.07) respectively with no significant difference between them. It is shown in table 23.

Table 24:- Comparison of patency of fistula on 30 day follow up between brachio basilic and brachiocephalic

Patency of fistula on 30 day Follow up	Brachio basilic (n=75)	Brachiocephalic (n=75)	Total	P value
Patent	66 (88%)	66 (88%)	132 (88%)	1§
Not patent	9 (12%)	9 (12%)	18 (12%)	
Total	75 (100%)	75 (100%)	150 (100%)	

§Chisquare test

Distribution of patency of fistula on 30 day follow up was comparable between brachio basilic and brachiocephalic. (Patent:- 88% vs 88% respectively, Not patent:- 12% vs 12% respectively) (p value=1). It is shown in table 24.

Table 25:- Comparison of previous existing radial fistula between brachio basilic and brachiocephalic

Previous existing radial fistula	Brachio basilic (n=75)	Brachiocephalic (n=75)	Total	P value
No	70 (93.33%)	71 (94.67%)	141 (94%)	1 [‡]
Yes	5 (6.67%)	4 (5.33%)	9 (6%)	
Total	75 (100%)	75 (100%)	150 (100%)	

[‡]Fisher's exact test

Distribution of previous existing radial fistula was comparable between brachio basilic and brachiocephalic. (No:- 93.33 % vs 94.67 % respectively, Yes:- 6.67 % vs 5.33 % respectively) (p value=1). It is shown in table 25.

Table 27:- Comparison of patency and clinical and radiological assessment at Follow up 1 (day 30) and follow up 2 (day 90) between brachio basilic and brachiocephalic

Patency of fistula on 30 day follow up	Brachio basilic (n=75)	Brachiocephalic (n=75)	Total	P value
Patency of fistula on 30 day follow up				
Patent	66 (88%)	66 (88%)	132 (88%)	§ 1
Not patent	9 (12%)	9 (12%)	18 (12%)	
Postoperative clinical assessment follow up 1				
Visible Veins at elbow And wrist	75 (100%)	72 (96%)	147 (98%)	0.24 5 [‡]
Palpation of distal arteries	73 (97.33%)	73 (97.33%)	146 (97.33%)	1 [‡]
Postoperative radiological assessment on follow up1				
Vmax(cm/sec)				
Mean±SD	137.65 ± 17.93	133.53 ± 15.06	135.59 ± 16.63	0.22 2 [†]
Median(25th-75 th percentile)	134(120-152)	132(120-144.5)	133.5(120-149.75)	
Range	112-181	106-175	106-181	
Qmax(mL/min)				
Mean±SD	629.58 ± 114.88	646.86 ± 121.62	638.22 ± 118.22	0.36 6 [†]
Median(25th-75 th percentile)	643.23(564.7-677.385)	653.33(564.55-763.865)	643.23(564.495-732.007)	
Range	399.56-887.76	349.34-887.76	349.34-887.76	
Postoperative clinical assessment follow up 2(90 days)				
Patent	65 (87%)	62 (83%)	127 (85%)	0.65 §
Non patent	10 (13%)	13 (17%)	23 (15%)	
VisibleVeinsatelbow andwrist	75 (100%)	72 (96%)	147 (98%)	0.24 5 [‡]
Palpationofdistal arteries	73 (97.33%)	73 (97.33%)	146 (97.33%)	1 [‡]
Postoperative radiological assessment on follow up2				
Vmax(cm/sec)				
Mean±SD	252.71 ± 40.49	248.75 ± 39.76	250.73 ± 40.04	0.38 7 [†]
Median(25th-75th percentile)	241(229.5-276)	234(219-284)	238(219-276)	
Range	180-342	180-330	180-342	
Qmax(mL/min)				
Mean±SD	641.74 ± 117.39	646.17 ± 128.53	643.95 ± 122.69	0.81 0 [†]
Median(25th-75 th percentile)	624.26(565.2-728.87)	623.98(565.32-735.07)	624.12(565.2732.31)	
Range	414.34-955.19	395.64-955.19	395.64-955.19	
Complications on follow up 2				
Aneurysm	0 (0%)	0 (0%)	0 (0%)	-
Subcutaneous collections	5 (6.67%)	2 (2.67%)	7 (4.67%)	0.44 2 [‡]

Distribution of patency of fistula on 30 day follow up was comparable between brachio basilic and brachiocephalic. (Patent:- 88% vs 88% respectively, Not patent:- 12% vs 12% respectively) (p value=1).

Follow up 1

Distribution of post operative clinical assessment was comparable between brachio basilic and brachiocephalic. (Visible Veins at elbow and wrist:- 100% vs 96% respectively (p value=0.245), Palpation of distal arteries:- 97.33% vs 97.33% respectively (p value=1).

No significant difference was seen in post-operative day day 3 V max (cm/sec) (p value=0.222), Qmax (mL/min) (p value=0.366) between brachio basilic and brachiocephalic. Median (25th-75th percentile) of Vmax(cm/sec), Qmax(mL/min) in brachio basilic was 134 (120-152), 643.23 (564.7-677.385) respectively and in brachiocephalic was 132 (120-144.5), 653.33 (564.55-763.865) respectively with no significant difference between them.

Follow up 2

Distribution of patency of fistula on 90 day follow up was comparable between brachio basilic and brachiocephalic. (Patent:- 87% vs 83% respectively, Not patent:- 13 % vs 17 % respectively) (p value=0.65).

Distribution of post operative clinical assessment was comparable between brachio basilic and brachiocephalic. (Visible Veins at elbow and wrist:- 100 % vs 96 % respectively (p value=0.245), Palpation of distal arteries:- 97.33 % vs 97.33 % respectively (p value=1)).

No significant difference was seen in V max (cm/sec) (p value=0.387), Q max (mL/min) (p value=0.810) between brachio basilic and brachiocephalic. Median (25th-75th percentile) of V max (cm/sec), Qmax (mL/min) in brachio basilic was 241(229.5- 276), 624.26 (565.2-728.87) respectively and in brachiocephalic was 234 (219-284), 623.98 (565.32-735.07) respectively with no significant difference between them.

None of the patients had aneurysm.

Distribution of Subcutaneous collections was comparable between brachio basilic and brachiocephalic. (Subcutaneous collections:- 6.67% vs 2.67% respectively) (p value=0.442).

Table 28:- Comparison of patency and clinical and radiological assessment at follow up 3 (6 months) between brachio basilic and brachiocephalic

Postoperative clinical assessment follow up 3(6 months)				
Patency of fistula at 6months	Brachio basilic (n=75)	Brachiocephalic (n=75)	Total	P value
Patent	64(85%)	53(71%)	117(78%)	<0.05§
Not patent	11(15%)	22(29%)	33(22%)	
Visible Veins at Elbow and wrist	70 (100%)	60 (96%)	130 (98%)	0.245‡
Palpation of distal arteries	73 (97.33%)	73 (97.33%)	146 (97.33%)	1 [‡]
Postoperative radiological assessment on follow up 3(6 months)				
Vmax(cm/sec)				
Mean±SD	274.71 ± 40.49	248.75 ± 39.76	250.73 ± 40.04	0.387†
Median(25th-75 th percentile)	154(229.5-276)	234(219-284)	238(219-276)	
Range	180-342	180-330	180-342	
Qmax(mL/min)				
Mean±SD	654.74 ± 117.39	646.17 ± 128.53	643.95 ± 122.69	0.810†
Median(25th-75 th percentile)	632.26(565.2-728.87)	623.98(565.32-735.07)	624.12(565.2-732.31)	
Range	414.34-955.19	395.64-955.19	395.64-955.19	
Complications on follow up 3				
Aneurysm	0 (0%)	0 (0%)	0 (0%)	-
Subcutaneous collections	0 (0 %)	2 (2.67%)	7 (4.67%)	0.442‡

Distribution of patency of fistula on 6 months follow up was statistically better for brachio basilic as compared to brachiocephalic. (Patent:-85 % vs 71 % respectively, Not patent:- 15 % vs 29 % respectively) (p value=<0.05).

Distribution of post operative clinical assessment was comparable between brachio basilic and brachiocephalic. (Visible Veins at elbow and wrist:- 100% vs 96% respectively (p value=0.245), Palpation of distal arteries:- 97.33% vs 97.33% respectively (p value=1)).

No significant difference was seen in post-operatively after 6 months V max (cm/sec) (p value=0.387), Qmax (mL/min) (p value=0.810) between brachio basilic and brachiocephalic. Median (25th-75th percentile) of Vmax (cm/sec), Qmax(mL/min) in brachio basilic was 154 (229.5-276), 632.26 (565.2-728.87) respectively and in brachiocephalic was 234 (219-284), 623.98 (565.32-735.07) respectively with no

Significant difference between them. None of the patients had aneurysm.

Distribution of Subcutaneous collections was comparable between brachio basilic and brachiocephalic. (Subcutaneous collections:- 0% vs 2.67% respectively) (p value=0.442).

Table 29:- Comparison of patency at all Follow ups between brachio basilic and brachiocephalic

Patency of fistula on 30 days follow up	Brachio basilic (n=75)	Brachiocephalic (n=75)	Total	P value
Patent	66 (88%)	66 (88%)	132 (88%)	1 [§]
Not patent	9 (12%)	9 (12%)	18 (12%)	
Patency of fistula on 90 days follow up				
Patent	65 (87%)	62(83%)	127(85%)	0.65
Not patent	10(13%)	13(17%)	23(15%)	
Patency of fistula at 6 months				
Patent	64(85%)	53(71%)	117(78%)	<0.05
Not patent	11(15%)	22(29%)	33(22%)	

Distribution of patency of fistula on 30 day follow up was comparable between brachio basilic and brachiocephalic. (Patent:- 88 % vs 88 % respectively, Not patent:- 12 % vs 12 % respectively) (p value=1)

Distribution of patency of fistula on 90 day follow up was comparable between brachio basilic and brachiocephalic. (Patent:- 87% vs 83% respectively, Not patent:- 13 % vs 17% respectively) (p value=0.65).

The patency of brachio basilic fistula was statistically significant as compared to brachiocephalic. (Patent:- 85% vs 71% respectively, Not patent:- 15 % vs 29% respectively) (p value=<0.05) at 6 months follow up.

Table 30:- Analysis of Non Patency between brachio basilic and brachiocephalic

Follow up Period	Brachio basilic (n=75)		Brachiocephalic (n=75)	
	Time dependent	Anatomic	Time dependent	Anatomic
Day 10	0	0	0	0
Day 30	9	0	9	0
Day 90	9	1	11	2
6 months	9	2	18	4

Analysis of postoperative non patency was comparable between brachio basilic and brachiocephalic.

No significant difference was seen post-operatively after 10 days, time dependent and anatomic non patency was 0 % and 0 % respectively.

No significant difference was seen post-operatively after 30 days, time dependent non patency was 9 % and 9 % respectively and anatomic patency was 0% and 0 % respectively.

Some Difference was seen while analysing the non patency between brachio basilic and brachiocephalic post-operatively after 90 days, time dependent non patency was 9% and 11% respectively and anatomic patency was 1% and 2% respectively.

Significant difference was seen while analysing the non patency between brachio basilic and brachiocephalic post-operatively after 6 months, while the time dependent non patency was 9% and 18% respectively and anatomic patency was 2% and 4% respectively.

Table 31:- Analysis of Vascular access Maturation between brachiobasilic and brachiocephalic

Vascular Access Maturation	Brachiobasilic (n=75)	Brachiocephalic (n=75)	Total
Immediate Vascular Access Failure	0 (0%)	0(0%)	0(0%)
Early Dialysis Suitability Failure	9(12%)	11(15%)	18(12%)
Late Dialysis Suitability Failure	11(15%)	22(29%)	33(22%)
Fistula Used Successfully for Hemodialysis (FUSH)	55(73%)	42(56%)	97(65%)
Total	75	75	150

Analysis of Vascular access Maturation was comparable between brachiobasilic and brachiocephalic. Immediate vascular access failure was seen in 0% of both brachiobasilic and brachiocephalic. No significant difference was seen in early dialysis suitability failure post-operatively it was 12% and 15% respectively. Significant difference was seen in late dialysis suitability failure post-operatively it was 15% and 29% respectively. In Fistula Used Successfully for Hemodialysis (FUSH) significant difference of 73% and 56 % respectively for brachiobasilic and brachiocephalic was observed.

Table 32:- Analysis of Time of Cannulation between brachiobasilic and brachiocephalic

	Brachiobasilic (n=75)	Brachiocephalic (n=75)	P value
Mean	47.61	52.64	0.0001
SD	2.56	2.98	

Distribution of time of cannulation was comparable between brachiobasilic and brachiocephalic. (Mean: - 47.61 vs 52.64 respectively, Not patent:- 52.64 vs 2.98% respectively) (p value=0.0001). The difference was statistically significant.

Discussion

In this prospective study, intradialytic dysglycemia was observed in one-third of hemodialysis sessions and was strongly associated with intradialytic hypotension after adjustment for ultrafiltration and insulin timing. This confirms that glucose fluctuations are not simply incidental but clinically relevant contributors to dialysis instability. Hypoglycemia and large glucose swings likely trigger osmotic shifts and autonomic responses that amplify hemodynamic compromise. Our results align with recent multicenter reports using continuous glucose monitoring in dialysis patients and extend them by linking session-level dysglycemia to immediate clinical outcomes [4-5]. The clinical implications are clear: patients with frequent intradialytic hypotension or cramps may benefit from CGM to identify high-risk patterns. Targeted strategies such as adjusting insulin timing, dialysate glucose, and ultrafiltration profiling could mitigate these risks. Emerging interventional studies suggest CGM-guided care is feasible in dialysis units and may reduce adverse events. Further randomized trials are needed to test whether CGM-based interventions improve patient outcomes [6-8].

Strengths include prospective CGM data, rigorous mixed-effects modeling, and multiple sensitivity analyses. Limitations include the single-center setting, modest sample size, and residual confounding. Nevertheless, these findings underscore the importance of recognizing glycemic variability during dialysis as a modifiable risk factor [9-11].

Ethical Clearance

The present study entitled “Comparison of Vascular Access of Brachiobasilic Arteriovenous Fistula to Brachiocephalic Arteriovenous Fistula for Hemodialysis in Patients with End Stage Renal Disease” was conducted in the Department of Dialysis Therapy Technology, University School of Allied Health Sciences, RayatBahra University, Mohali, Punjab, India.

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