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Original research article

COMPARING CREATININE TO UREA VOLUME (KT/V) AMONG ARTERIOVENOUS FISTULA, VASCULAR GRAFT, AND TUNNELED CUFFED CATHETERS: A RETROSPECTIVE STUDY

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Abstract: *Hemodialysis patients may employ three different kinds of vascular access: permanent catheter (PC), arteriovenous fistula (AVF), and vascular graft (AVG). This research was done to compare AVF, AVG, and PC regarding dialysis adequacy since there is a lack of data on the subject.* ***Methods:*** *This was a two-year retrospective study. Two hundred hemodialysis patients participated in the research and were randomly allocated to one of three groups: AVF, AVG, or PC. Blood was drawn before and after a dialysis treatment to analyze the urea reduction ratio (URR) and creatinine to urea volume (Kt/V). Laboratory tests were redone after six months of monitoring the patients.* ***Results:*** *A total of 200 patients were divided into three groups based on the type of vascular access: AVF (n=137), AVG (n=36), and PC (n=27). The Mean ± S.D of the patient's age in AVF, AVG, and PC were 58.6±14.7, 60.5±0.5, and 53.6±25.0 years respectively. The Mean ± S.D of Kt/v in AVF, AVG, and PC were 1.2±0.3, 1.4±0.2, and 1.1±0.4 respectively. A significant Variation (p=0.012) in the mean Kt/v of the study groups was observed in the present study. The Mean ± S.D of URR in AVF, AVG and PC were 64.3±7.9, 69.1±3.1, and 62.8±5.1 respectively. A significant Variation (p=0.000) in the mean URR of the study groups was observed in the present study.* ***Conclusion:*** *AVF and AVG have superior hemodialysis adequacy regarding Kt/v and URR over PC.*

Keywords: Arteriovenous Fistula, Dialysis, Permanent Catheter, Pakistan, Vascular Graft.

Introduction

Hemodialysis (HD) procedures necessitate vascular access. In clinical practice, vascular access can be gained through a variety of means, including tunneled/non-tunneled, arteriovenous grafts, native arteriovenous fistulae (AVF), and cuffed/non-cuffed central venous catheters (CVCs) (1, 2). A patient's vascular status, physician preference, comorbidities, functional performance, nutritional status, pre-dialysis insurance status, the timing of nephrologist referral, etc., all play a role in determining which vascular access method will be used. In HD, catheters are associated with an increased risk of thrombosis, infection, a decreased delivered HD dose, and a shorter lifespan (3, 4). Moreover, using a catheter rather than a patient's own native AVF is linked to a higher mortality rate. Because of this, AVF is highly recommended by clinical guidelines for HD, which will last a long time. The ever-changing nature of vascular access throughout time is a barrier to research on the correlation between vascular access and mortality in HD patients (5, 6). Catheter users had a 70% greater risk of death in the first year after incident HD compared to AVF users, according to recent research using Medicare procedure records by Xue et al. (7). The possible time effect of catheter usage on the risk of eventual death in HD patients could not be adjusted for since the research did not assess the length of the catheter use. The CHOICE research studied the evolution of vascular access methods better to understand the causes of death (8).
When employing CVCs, the luminal width, catheter length, and insertion site all impact the pre-pump inflow pressure. The luminal widths of acute CVCs for hemodialysis are often lower, and the CVC tips are typically in central veins rather than the right atrium (9). In contrast, cuffed tunneled CVCs for hemodialysis have greater luminal diameters and need to be implanted under fluoroscopic guidance. To maximize the effectiveness of dialysis, the biggest CVC is inserted into the right atrium directly (10).
Compared to CVCs, AV access—whether AVF or AVG—supports more blood with less negative input arterial pressures; the effectiveness of permanent vascular access is influenced by several variables. Dialysis needles are used to pump blood to and from the AV access, and they have tiny luminal diameters and high flow resistances, which reduce blood flow. Low access blood flow is a significant factor in the ineffective delivery of dialysis to specific patients, and AV access may also produce large amounts of recirculation. Even in the presence of functional, fully developed vascular access, limited access to blood flow may result from venous stenosis, intra-access stenosis, or arterial input stenosis in the AVF. It may, therefore, lead to insufficient hemodialysis (10).
The current NKF-KDOQI Guidelines do not recommend a daily estimate of dialysis adequacy. This strategy is predicated on the notion that monthly observations provide an accurate Kt/V (to determine the dose of delivered dialysis per fraction removal of urea) (11). Several parameters, including patient compliance, the length and frequency of dialysis treatments, recirculation during dialysis, and blood flow via vascular access, impact Kt/V, a measure of the sufficiency of the dialysis process. A Kt/V number between

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1.2 and 1.4 is regarded as sufficient and has been shown to provide good results, whereas a value below 1.0 is linked to a much-increased likelihood of unfavorable results (12).
There isn't much information comparing the sufficiency of dialysis-dependent on the kind of vascular access, and the few studies that have been done have certain restrictions, including using just one type of vascular access and having a limited sample size. Therefore, this research aims to analyze the effectiveness of various vascular access methods, such as permanent catheters, fistulas, and grafts, and to identify the variables that influence the clearance in dialysis for patients utilizing various AV access methods.

Methodology

This retrospective observational study was conducted for two years (1st April 2017 to 31st March 2019) in the Hemodialysis Unit, Department of Medicine, Section of Nephrology, Aga Khan University Hospital (AKUH), Karachi (ERC No. 2019-1084-2988). The participants recruited in this study were of all age groups, both genders, were hemodialysis dependent for at least three months, and the recruited participants with Kt/V checked at least twice during their treatment at AKUH. Any participant not giving consent for participation or missing data was excluded. A total of 200 HD patients fulfilling the above criterion was selected, and their clinical and demographic parameters (age, gender, BMI, HD frequency, vascular access, body surface area, blood flow rate, Kt/v, urea reduction rate (URR), hemoglobin) were collected through a duly filled proforma. For descriptive statistics, means with standard deviation will be reported for all quantitative variables with normal distribution, whereas median with interquartile range will be reported for all variables with skewed distribution. Quantitative variables include age, weight, BMI, body surface area, Pre-HD, and Post–HD BUN, etc. For categorical variables such as gender, vascular access, dialyzer surface area, blood flow rate, etc., frequencies with percentages will be reported. Quantitative variables will be compared across the categories of dialysis adequacy using an independent sample t-test, whereas categorical variables will be compared using a chi-square test. P value ≤ 0.05 was considered significant in all statistical analyses. IBM SPSS Statistics for Windows, Version 26.0. Armonk, NY: IBM Corp. was utilized to carry out all the statistical significance tests.

Results

A total of 200 patients on hemodialysis were included in the present study and were divided into three groups based on the type of vascular access: AVF (n=137), AVG (n=36), and Permanent Catheters PC (n=27). The Mean ± S.D of the patient's age in AVF, AVG, and PC were 58.6±14.7, 60.47±0.5, and 53.55±25.0 years, respectively (Table 1). The Mean ± S.D of the patient's BMI in AVF, AVG, and PC were 27.8±3.5, 19,59±1.1, and 25.17±8.12 kg/m2, respectively. A significant Variation (p=0.000) in the mean BMI of the study groups was observed in the present study (Table 1). All the groups were dominant with the female population, except AVF, which had more male patients.

Table 1: Clinical and demographic characteristics of the hemodialysis patients

	AVF (n=137)	AVG (n=36)	PC (n=25)	P Value
Age				0.1822
Mean	58.6	60.47	53.55	
S. D	14.7	0.5	25	
BMI				0.000*
Mean	27.8	19.59	25.17	
S. D	3.5	1.1	8.12	
Gender				
Females	44(32%)	36 (100%)	21(78%)	
Males	93(68%)	0	6(22%)	

AVF: Arteriovenous Fistula; AVG: Vascular Graft; PC: Permanent Catheter. S.D: Standard Deviation; BMI: Body Mass Index
*Statistically significant. P-value<0.05.

In the AVG groups, all the patients had an HD frequency of two times per week, while in the AVF and PC groups, most patients had an HD frequency of three times per week. The Mean ± S.D of dialyzer surface area in AVF, AVG, and PC were 1.78±0.07, 1.4±6.7E-16, and 1.53±0.37 respectively (Table 2). The Mean ± S.D of the patient's body surface area I in AVF, AVG, and PC were 1.83±0.18, 1.36±0.025, and 1.6±0.36 respectively. A significant Variation (p=0.000) in the mean body surface area of the study groups was observed in the present study. The dialysis flow rate in all three groups was 500mL/min. The Mean ± S.D of the blood flow rate in AVF, AVG, and PC were 296±59.4, 256.69±28.27, and 271±79.8 respectively. A significant Variation (p=0.0010) in the mean blood flow rate of the study groups was observed in the present study (Table 2).
The Mean ± S.D of Kt/v in AVF, AVG, and PC were 1.23±0.27, 1.36±0.17, and 1.11±0.36 respectively. A significant Variation (p=0.012) in the mean Kt/v of the study groups was observed in the present study. The Mean ± S.D of URR in AVF, AVG, and PC were 64.3±7.9, 69.08±3.14, and 62.8±5.07 respectively. A significant Variation (p=0.000) in the mean URR of the study groups was observed in the present study (Table 2). The Mean ± S.D of Pre-BUN in AVF, AVG, and PC were 55±17.3, 55.83±15.54, and 67.9±18.1 respectively. A significant Variation (p=0.0018) in the mean Pre-BUN of the study groups was observed in the present study. The Mean ± S.D of Post-BUN in AVF, AVG, and PC were 17±8.04, 12.08±5.14, and 20.03±16.0 respectively. A significant Variation (p=0.0021) in the mean post-BUN of the study groups was observed in the present study. The Mean ± S.D

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of HD duration in AVF, AVG, and PC were 4±0.2, 3.95±1.40, and 3.61±0.47respectively. A significant variation (p=0.000) in the mean HD duration of the study groups was observed in the present study (Table 2).

Table 2: Dialysis Parameters of the participants in the AVG, AVF, and PC study groups

Dialysis Parameters	AVF (n=137)	AVG (n=36)	PC (n=25)	P Value
HD Frequency	3/weeks (84%), 2/weeks (16%)	2/week	Three/ weeks (52%), 2/Weeks (48%)	
K/tv	1.23±0.27	1.36±0.17	1.11±0.36	0.012*
Dialyzer surface area	1.78±0.07	1.4±6.7E-16	1.53±0.37	
Body surface area	1.83±0.18	1.36±0.025	1.6±0.36	0.000*
Dialysis Flow Rate	500 ml/min	500 ml/min	500 ml/min	
Average UF	500-1000mL/H (4%), Less than 500mL/H (11%), more than 1L/H (85%)	more than 1L/hour	500-1000mL/H (33%), Less than 500mL/H (4%), more than 1L/H (64%)	
Blood Flow rate (mL/min)	296±59.4	256.69±28.27	271±79.8	0.0010*
Hb	11.03±1.6	10.08±1.45	9.4±1.64	0.000*
URR	64.3±7.9	69.08±3.14	62.8±5.07	0.0004*
Pre-BUN	55±17.3	55.83±15.54	67.9±18.1	0.0018*
Post-BUN	17±8.04	12.08±5.14	20.03±16.0	0.0021*
Duration of HD	4±0.2	3.95±1.40	3.61±0.47	0.000*
History of HD				
<6 months	0	0	11(41%)	
> 6 months	9(7%)	17 (47.2%)	2(7%)	
> 1 year	128(93%)	19 (53%)	14(52%)	
Other commodities				
DM	104(76%)	17 (47.2%)	12(44%)	
HTN	137(100%)	0	0	

AVF: Arteriovenous Fistula; AVG: Vascular Graft; PC: Permanent Catheter. S.D: Standard Deviation; HD: Hemodialysis; Kt/V: Creatinine to urea volume; Hb: Hemoglobin; BUN: Blood Urea Nitrogen; DM: Diabetes Mellitus; HTN: Hypertension.
*Statistically significant. P-value<0.05.

Discussion

The present study showed that AVF and AVG are superior in terms of Kt/v and URR than PC, proving that AVG and AVF have greater dialysis adequacy than PC vascular access. Results from studies comparing the efficacy of dialysis using various vascular routes have been mixed. For instance, Canaud et al. studied hemodialysis outcomes on 42 patients throughout two 12-month periods. After the first 12 months of hemodialysis with PC, an AVF was implanted for a further 12 months. Patients with PC were provided lengthier dialysis sessions after researchers found that dialysis adequacy (as evaluated by Kt/V) was marginally worse in PC than in AVF [13]. In addition, Canaud et al. examined dialysis adequacy and mean blood flow across patients using an AVF, PC, and temporary catheter (TC) and found that the AVF group fared best (13). Ethier et al. conducted multicenter research across many countries. They discovered that dialysis adequacy was greater in patients with AVF than in patients with PC and that VG was the recommended vascular access method after AVF (14). To conclude that appropriate Kt/V was reached in both the AVF and PC groups, Tonelli et al. followed up with 53 hemodialysis patients for three weeks. However, AVF was shown to be better in this research regarding dialysis adequacy, suggesting that discrepancies across studies may be attributable to factors like sample size and length of follow-up (15). Research conducted by Canaud et al. on hemodialysis patients shows that PC is an excellent approach with few problems for the elderly (16). An increased initial failure rate, lengthier catheter reliance, and more frequent catheter-related bacteremia in the fistula were all documented by Lee et al. in their comparison of AVF and grafts (17). It was also found by Hicks et al. that AVF outperformed VG and PC in all patient ages. Patients older than 48 or younger than 18 may benefit more from VG than PC (18). In research including 583 hemodialysis patients, Banerjee et al. found that PC placements were associated with higher rates of inflammation and death than AVF placements (19). In research including 358 hemodialysis patients, Karkar et al. found a substantial drop in hospitalization rates with improved blood flow, Kt/V, hemoglobin, serum albumin, and erythropoietin given each session. Regarding hemodialysis quality and patient outcomes, they found that AVF was much better than PC [19]. Due to the study's limitations (such as its small sample size and relatively short follow-up period), more research should be conducted using a bigger sample size and a more extended follow-up period.

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Conclusion

Several studies have shown that AVF and AVG are preferable to PC in reducing the risk of infection and thrombosis. Because we observed that AVF and AVG also improved dialysis efficacy, it is recommended that all CKD patients eligible for hemodialysis have the procedure.

Declarations

Data Availability statement
All data generated or analyzed during the study are included in the manuscript.
Ethics approval and consent to participate.
It is approved by the department concerned. (ERC No. 2019-1084-2988)
Consent for publication
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Conflict of interest

The authors declared an absence of conflict of interest.

Authors Contribution

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