

Comparison of success rate of arterio-venous fistula in patients with diabetes vs non-diabetes

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Abstract

Introduction: Definition of chronic renal disease is based on the presence of kidney damage or glomerular filtration rate (GFR 60 ml/min per 1.73 m²) for 3 months, irrespective of cause. Once they are diagnosed as CKD, they are kept either on hemodialysis or peritoneal dialysis or patient undergo renal transplant. With this research we may prove that even in a similar circumstances failure rate of AVF is more in diabetes patient.

Methods: Total 50 patients of either gender were taken in this study. Inclusion criteria: CRF with GFR <30ml/min. Arterial diameter >1.5mm and venous diameter >2mm. Preoperative radial artery blood flow >30cm/min. Exclusion criteria: arterial diameter <1.5mm venous diameter <2mm. Written consent was taken from the patient. After preoperative workup surgery was done by 1st author. Arterio-venous fistula was scanned by color Doppler imaging after 4 weeks.

Result: There were 31 [62%] male, 19 [38%] female. Mean age of patients was 55.8 years. 18(36%) were dialysis dependent. Cause of renal failure were diabetes 16(32%), unknown 15(30%), glomerulonephritis 8(16%) and obstructive uropathy 3(6%). Mean internal diameter of radial artery was 1.91mm (1.5-2.6) and cephalic vein 2.57mm (1.9-3.2). 7 patients had swelling of arm, 5 patients had surgical site infections and 15 patients had primary failure; 11 were from diabetic group and 4 from non-diabetic group. Mean duration of surgery was 60.95 minutes (50-75). Average preoperative velocity in radial artery was 32.94(30-39)cm/sec. Average flow of blood at the end of 4 weeks was 461.42ml/min (0-654). Between two groups failure rate was significantly high in diabetic patients (p = 0.02). Failure rate was significantly higher in patients with diabetes more than 10 years (p=0.01).

Conclusion: Failure rate of arterio-venous fistula is significantly high in diabetic patients.

Key words: Arterio-venous fistula; CRF; diabetes mellitus.

Introduction

Chronic Kidney Disease is a common disease. The prevalence rate of Renal Replacement Therapy (RRT) is 644 patients per million people in the 15 countries of the European Union, where the average gross income is over US \$22,000 per capita, as compared with a prevalence rate of 166 patients per million population in Central and Eastern European countries, where the average per capita income is US \$4480¹. The incidence of ESRD is estimated

to be 100 per million populations (pmp) in South Asian countries Pakistan, India and Bangladesh.² In Nepal we do not have any reliable study highlighting the prevalence of the chronic kidney disease. Study done 15 years back shown to have prevalence to be 11.89 pmp in 1999 with an average annual incidence of 6 pmp and only 0.31% of expected ESRD patients received RRT.³

Incidence of chronic renal disease is increasing day by day. As a part of renal replacement therapy, hemodialysis was started in Bir Hospital since 1995. Since then other government and private hospital / institutions started the hemodialysis and other parts of renal replacement therapy. Since 2008 Trivuwun University Teaching Hospital [TUTH] and Bir Hospital started live related renal transplantation. So far >500 renal transplantation conducted in Nepal itself. But it is a very small number to meet the actual demand. So dialysis is the main mode of treatment for the patient of End Stage Renal Disease [ESRD].

Timely construction of arterio-venous Fistula is the main initial step in the management of Chronic Kidney Disease. Arterio-venous Fistula is made by Vascular surgeon, urologist, general surgeon or Nephrologist but it requires a surgeon to learn a particular skill and experience.

Methods

Total 50 patients of either gender were taken in this study. Inclusion criteria: CRF with GFR <30ml/min. Arterial diameter >1.5mm and venous diameter >2mm. Preoperativeradial artery blood flow >30cm/min. Exclusion criteria: arterial diameter <1.5mm venous diameter

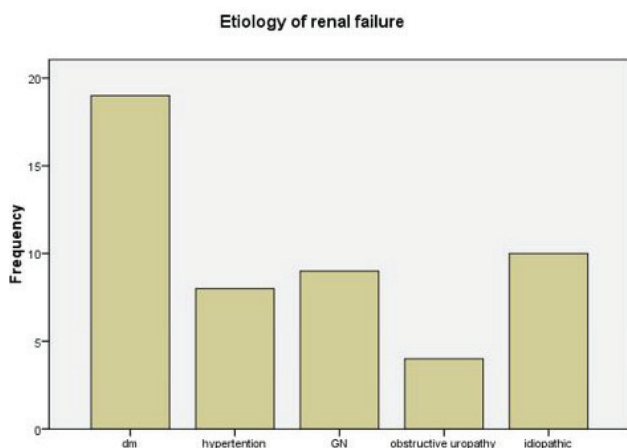
<2mm. Written consent was taken from the patient. After preoperative workup surgery was done by 1st author. Arterio-venous fistula was scanned by color Doppler imaging after 4 weeks.

Complications

| Type | Non-diabetic | Diabetic |
|---------------------|--------------|----------|
| Bleeding postop | 0 | 2 |
| Wound infection | 1 | 5 |
| Swelling of forearm | 1 | 5 |
| Early thrombosis | 1 | 3 |
| Delay maturation | 4 | 7 |

Patient Demographic Characteristics

| | Non-diabetic patients (n = 50) | Diabetic patients (n = 50) | P value |
|----------------------------------|-----------------------------------|-------------------------------|---------|
| Age (years) | 53±10 | 57±15 | 0.08 |
| Gender (male / female) | 15/10 | 18/9 | 0.09 |
| Dialysis dependent | 7 | 11 | 0.06 |
| hypertension | 8 | 8 | 0.1 |
| Internal arterial diameter [mm] | 1.91±0.23 | 1.89±0.27 | 0.08 |
| Internal venous diameter[mm] | 2.51±0.37 | 2.51±0.45 | 0.09 |
| Arterial velocity preop [cm/sec] | 32.94±2.45 | 26±2.03 | 0.03 |
| Primary failure | 4 | 15 | 0.02 |
| Duration of surgery[min] | 60.9±6.60 | 62.45±4.56 | 0.09 |
| AVF velocity[ml/min] | 461.1±154.3 | 401.3±100.6 | 0.03 |



Data analysis:

- SPSS for windows (version 17.0, SPSS, INC., Chicago, IC) will be used for statistical analysis.
- The collected data are depicted in tabular form and interpreted statistically and analyzed.
- Frequency and percentage will be calculated for gender, comorbidities, complications and primary failure rate
- Quantitative variables as age, diameter of artery and vein, blood flow in artery and arterio-venous fistula are expressed in mean \pm standard deviation (SD), median and range
- 0.95 will be taken as statistical power of sample.
- P value <0.5 will be considered statistically significant.
- Stratification will be done to control effect modifier like age, gender, duration of disease, stage, educational status and economic status to see the effect of these on outcome
- Pearson's Chi-Square test will be used for quantifying the association between the categorical outcome.

Results

There were 31(62%) male, 19(38%) female. Mean age of patients was 55.8 years. 18[36%] were dialysis dependent. Cause of renal failure were diabetes 16(32%), unknown 15(30%), glomerulonephritis 8(6%) and obstructive uropathy 3(6%). Mean internal diameter of radial artery was 1.91mm (1.5-2.6) and cephalic vein 2.57mm (1.9-3.2). 7 patients had swelling of arm, 5 patients has surgical site infections and 15 patients had primary failure; 11 were

from diabetic group and 4 from non-diabetic group. Mean duration of surgery was 60.95 minutes (50-75). Average preoperative velocity in radial artery was 32.94[30-39] cm/sec. Average flow of blood at the end of 4 weeks was 461.42ml/min (0-654). Between two groups failure rate was significantly high in diabetic patients ($p = 0.02$). Failure rate was significantly higher in patients with diabetes more than 10 years ($p=0.01$).

Discussion

Our findings demonstrate that in the similar situation diabetic patients has increased risk of primary failure of arterio-venous fistula. Patient who is diabetic for >7 years ($p<0.03$) are increased risk factor for primary failure. For the successful functioning of arterio-venous fistula good healthy artery and vein is required. After the construction of arterio-venous fistula, blood flow through the fistula increases. For a successfully running arterio-venous fistula at least 400ml/min of blood flow is required. To maintain this blood flow arterial inflow should also develop. In diabetic patients although artery may appear healthy but their capacity to develop is hampered by arteriosclerosis and atherosclerosis. So, significant number of arterio-venous fistula does not mature enough to become suitable for the dialysis.

Primary failure rate in this study is around 30%. In non-diabetic patients its around 16% and in diabetic patients the failure rate is 28%. Autogeneous wrist fistulas have high levels of inadequate maturation ($30\pm 80\%$) as well as lower patency in diabetics attributed to high levels of pre-existing intimal hyperplasia and atheroma in distal veins and arteries respectively.^{4,5}The maturation time of fistula is 60 days in non-diabetic patients and 75 days for diabetic patients. Time taken by fistula for maturation is comparable to the results of Patel et al.⁶

We usually plan to construct AV Fistula as distally as possible as advised by NKF K/DOQI. But in special circumstances as diabetes functional maturity is poor in wrist fistula. Different factors come into play for the success of AV Fistula. Size of artery and vein, comorbid conditions as diabetes, hypertension, cardiac problem and the experience of the surgeon. There are different minimal threshold send regarding the size of radial artery and radial vein.

While considering size of the vein to predict the success of AV fistula Pouseuille's law is applied which is ($Q \propto \Delta P \times r^4/\eta$). Flow (Q) is proportional to the product of change in pressure gradient (ΔP) and the fourth power of the vessel

radius (r) divided by the viscosity (η) of blood. Larger veins (radius) mean larger flow. But this does not consider the impact of arterial factors and normal pulsatile blood flow.⁷In this study we have considered ≥ 1.5 mm as radial artery diameter and 2mm as cephalic vein diameter for the construction of arterio-venous fistula. Silva et al⁹ had minimum of 2.5 mm for vein size as predictable for fistula success.

After the construction of AV fistula functional maturation of the fistula is required for the dialysis. There are different criteria to define the functional maturation. NKFK/DOQI glossary has defined fistula maturation as “the process by which a fistula becomes suitable for cannulation” and focuses on the Rules of Sixes: blood flow greater than 600mL/min; a diameter greater than 0.6 cm; and a depth of approximately 0.6 cm. Functional patency is defined as is the ability of a hemodialysis access to deliver a flow rate of 350 to 400 mL/min without access recirculation to maintain a treatment time of less than four hours. Dember et al identifies functional maturation, in a randomized control trial for the Dialysis Access Consortium, as fistula suitability with two needles to maintain an optimal dialysis flow rates of 300 mL/min during eight of 12 dialysis sessions.⁹

There are certain limitations of this study. Sample size of is small in size. As we have recently started to use collar Doppler imaging to determine the size of artery and vein as well as blood flow rate in AV fistula, measurement may not be accurate. There are certain confounding factors in this study as hypertension which may affect the health of artery and vein. We did not include the HbA1c status of the patients. So we could not compare the correlation between good controlled blood sugar and success of arterio-venous fistula.

Conclusion

Construction of arterio-venous fistula at wrist in a diabetes has significant primary failure rate. Color Doppler ultrasound assessment of vessel allow us to screen the patient for the proper selection of the patient. Proximal arterio-venous fistula at elbow is recommended in a diabetic patient.

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