A Prospective Study of Creation of Arteriovenous Fistula in Chronic Renal Failure Patients for Haemodialysis access and associated Outcomes – “Our Experience At a Tertiary Care Centre”

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Abstract- Chronic kidney disease (CKD) also known as chronic renal disease, is a progressive loss in kidney function over a period of months or years. Haemodialysis is a proven method of removing waste products and extra fluid, which build up in the blood when the kidneys are no longer able to function properly. To accomplish haemodialysis it is necessary to have easy access to the blood vessels. Creation of an Arteriovenous fistula creates the necessary access for haemodialysis.

Aims and Objectives – To share our experience in creating arteriovenous fistula for haemodialysis.

Materials and Methods- The study was conducted in our hospital between August 2019 to July, 2021 including 50 patients of Chronic renal failure with AV Fistulae coming for regular follow-up.

Inclusion Criteria: All patients with chronic renal failure requiring AV-fistula access for Dialysis were included in this study.

Exclusion criteria : Patients with thrombosed Cephalic vein were excluded from this study. The AV-Fistula was created between Radial artery and Cephalic vein in lower lateral part of Non-dominant hand.

Introduction- An arteriovenous fistula (AV fistula) is connection of a vein and an artery, usually in the forearm, to access to the vascular system for haemodialysis, a procedure that performs the functions of the kidneys which had failed. Once kidney function goes below 10 to 15 percent of normal, dialysis treatment or transplantation are necessary to sustain life. Dialysis cannot replace kidneys, or restore them but they can prolong life often for years, by preventing the build up of waste products in the body. Haemodialysis cleans blood by removing it from body and passing it through a dialyser or an artificial kidney. When an artery and vein are joined together the vein gradually becomes larger and stronger, creating the fistula provides vascular access which last longer than other types of access with fewer complications. In 1962 James E. Cimino and Michael J. Brescia (New York, USA) described a simple venipuncture for hemodialysis based on the experience of Dr Cimino. In 1966 the legendary paper Chronic hemodialysis using venipuncture and a surgically created arteriovenous fistula was published by Brescia, Cimino, Appell and Hurwich. The first surgically created fistula for the purpose of haemodialysis was placed on 19 February 1965, followed by further 14 operations as of 21 June 1966. Twelve out of these 14 AV- fistulae resumed primary function without complications, two never functioned (in the first patient, the anastomosis was made too small). There are three basic types of AVF – the radial-cephalic, the brachio-cephalic and the brachio-basilic transposition. The above is the order of preference for the creation of a permanent vascular access as recommended by NKF-K/DOQI guideline. Of the three types of AVF, the radial-cephalic fistula is the easiest to create.

Table 1 – Order of Preference for Permanent Vascular Access

1) Radial-cephalic fistula
2) Brachio-cephalic fistula
3) Brachio-basilic transposition fistula
4) Arteriovenous graft

Table 2 – General Characteristics Of AV-Fistulas

1. Created with minimal patient morbidity
2. Require a period of maturation prior to use
3. Increase in size with time
4. Flow increases with time
Complications Of Arteriovenous Fistulas

Although the AVF is associated with fewer complications than are seen with other types of vascular access, they do occur and they should be dealt with effectively.

Causes of Early Fistula Failure (≤ 3 months post-surgery)

Inflow problems:
Pre-existing arterial anomalies
Anatomically small
Atherosclerotic disease

Acquired
Juxta-anastomotic stenosis

Outflow problems:
Pre-existing venous anomalies
Anatomically small
Fibrocystic vein (stenotic)
Accessory veins (side branches)

Late Fistula Failure
Late fistula failure is defined as failure that occurs after 3 months. The primary causes of failure occurring at this time are venous stenosis and acquired arterial lesions.
1. Venous Stenosis
2. Thrombosis - the most common mechanism for late fistula failures
3. Acquired Arterial Lesions - Many dialysis patients either have significant vascular disease when they begin dialysis or are predisposed to its development
4. Excessive Flow - Excessive flow, which is relative, can result in two problems – ischaemia and high cardiac output. The creation of a low resistance shunt in the arm as represented by the AV fistula can result in the development of ischaemic problems in the hand and fingers. This happens because the resistance to flow through the smaller vessels of the hand and digits far exceeding the resistance to flow through the shunt. As previously mentioned, blood flow in an AV fistula has a tendency to increase with the passage of time. This can eventually lead to high output cardiac failure. When this occurs, the fistula may require ligation.
5. Aneurysm Formation - The increase in blood flow in an AV fistula that occurs with time has a tendency to cause the vessel to continue to increase in size. Over a period of years the AV fistula can dilate to aneurysmal proportions. Aneurysm formation may occur because of repeated punctures that can weaken the vein wall in some patients. The incidence of aneurysm formation is approximately 5% to 6%.
6. Infections - Infections of primary arteriovenous fistulas are rare and basically represent a vasculitis
7. Edema - Thrombophlebitis is most common reason for AV-fistula access site edema but rare causes of allergic reactions have been noted too. Hemodialysis tubing contain di(2-ethylhexyl)phthalate (DEHP) and is responsible for allergic dermatitis and edema few patients. Those were edema and erythema do not improve then hemodialysis tubings can be replaced with a product containing trioctyl trimellitate (TOTM) rather than DEHP.

- Pathophysiologic events of successful arteriovenous fistula (AVF) maturation and AVF maturation failure. Left panel describes events of successful AVF maturation and right panel describes events of AVF maturation failure. Successful AVF maturation is dependent on outward vascular remodeling and inhibition of neointimal hyperplasia, regulated through nitric oxide production and appropriate regulation of matrix metalloproteinases. Fibroblast, smooth muscle cell, and myofibroblast activation, migration and proliferation play a key role in neointimal hyperplasia development and AVF maturation failure. Mediators such as heme-oxygenase-1 (HO-1), monocyte chemoattractant protein (MCP-1), kruppel-like factor-2 (KLF-2), transforming growth factor beta (TGF-b1), and high levels of local oxidant stress (e.g., peroxynitrite), play essential roles in regulating cellular proliferation and neointimal hyperplasia development.

Maturation towards use of the AV fistula should occur at 4 to 6 weeks with a basic AV fistula. An AV fistula that cannot be successfully cannulated by 90 days post-operatively should reconsidered a failed AV fistula.
### TABLE 1

<table>
<thead>
<tr>
<th>SEX</th>
<th>Number of Patients</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>26</td>
<td>52</td>
</tr>
<tr>
<td>Female</td>
<td>24</td>
<td>48</td>
</tr>
<tr>
<td>Total</td>
<td>50</td>
<td>100</td>
</tr>
</tbody>
</table>

**COMMENT:**
The table reveals that 52% of the operated cases are males and 48% are females.

**FIGURE 1:** Local anesthesia given at local site with 1% lignocaine for creation of AV-fistula between cephalic vein and radial artery.

**FIGURE 2:** Skin incision followed by blunt dissection to identify cephalic vein first and then mobilizing the vein for a distance of 1-2 cm.

**FIGURE 3:** Completely mobilizing the cephalic vein with careful traction given.

**FIGURE 4:** Blunt dissection done to identify radial artery and mobilizing radial artery for 1-2 cm with minimum possible traction given.

**FIGURE 5:** Posterior-wall anastomosis being done between Radial artery and Cephalic vein.

**FIGURE 6:** Anterior-wall anastomosis between Radial artery and Cephalic vein.
TABLE – 2

AGE DISTRIBUTION

<table>
<thead>
<tr>
<th>AGE (YEARS)</th>
<th>NO OF PATIENTS</th>
<th>PERCENTAGE(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10-20</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>20-30</td>
<td>6</td>
<td>12</td>
</tr>
<tr>
<td>30-40</td>
<td>8</td>
<td>16</td>
</tr>
<tr>
<td>40-50</td>
<td>8</td>
<td>16</td>
</tr>
<tr>
<td>50-60</td>
<td>13</td>
<td>26</td>
</tr>
<tr>
<td>60-70</td>
<td>9</td>
<td>18</td>
</tr>
<tr>
<td>70-80</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>TOTAL</td>
<td>50</td>
<td>100</td>
</tr>
</tbody>
</table>

COMMENT:
The table reveals that the age group of 50-60 years contains maximum number of patients.

TABLE-3

OUTCOME

<table>
<thead>
<tr>
<th>NUMBER</th>
<th>PERCENTAGE(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. FUNCTIONING</td>
<td>42</td>
</tr>
<tr>
<td>2. NON-FUNCTIONING</td>
<td>8</td>
</tr>
<tr>
<td>TOTAL</td>
<td>50</td>
</tr>
</tbody>
</table>
COMMENT:
In this study out of 50 fistula, 42(84%) was functioning and 8(16%) was non-functioning.

<table>
<thead>
<tr>
<th>COMORBIDITY</th>
<th>NUMBER</th>
<th>PERCENTAGE(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-DIABETES</td>
<td>4</td>
<td>50</td>
</tr>
<tr>
<td>2-IHD</td>
<td>2</td>
<td>25</td>
</tr>
<tr>
<td>3-NO COMORBIDITY</td>
<td>2</td>
<td>25</td>
</tr>
<tr>
<td>TOTAL</td>
<td>8</td>
<td>100</td>
</tr>
</tbody>
</table>

COMMENT:
Out of total 8 failures, 4 (50%) patients had diabetes mellitus, 2 (25%) patients had ischaemic heart disease and 2 (25%) had no co-morbidity.
TABLE-5

COMPLICATIONS

<table>
<thead>
<tr>
<th>COMPLICATIONS</th>
<th>NUMBER OF PATIENTS</th>
<th>PERCENTAGE (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. FAILURE</td>
<td>8</td>
<td>16</td>
</tr>
<tr>
<td>2. ANEURYSM</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>2. WOUND INFECTION</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>4. EDEMA</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>5. MORTALITY</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

COMMENTS
- Patients in which AV fistula failed were advised to do refistula at higher site or at opposite limb. Out of 50 patients, 8 (16%) had failure of AV-fistula, 2 (4%) developed aneurysm, 3 (6%) had wound infection and 2 (4%) developed edema in operative site.
- In patients where aneurysm developed, fistula was closed and refistula was created at higher site.
- Wound infection was treated with higher antibiotics.
- Patients who developed oedema were treated by aggressive management of chronic renal failure and limb elevation.
- There was no per operative mortality noted in any patient.

TABLE-6

SITE/LIMB OF AV-FISTULA CREATION

<table>
<thead>
<tr>
<th>SR. NO</th>
<th>LIMB/SITE</th>
<th>NUMBER OF PATIENTS</th>
<th>PERCENTAGE(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Left-hand</td>
<td>42</td>
<td>84%</td>
</tr>
<tr>
<td>2.</td>
<td>Right-hand</td>
<td>8</td>
<td>16%</td>
</tr>
<tr>
<td>TOTAL</td>
<td></td>
<td>50</td>
<td>100%</td>
</tr>
</tbody>
</table>
In my study, 42 (84%) AV-fistulas were created in left hand and 8(16%) were created in right hand.

TABLE-7
PREOPERATIVE LABORATORY INVESTIGATIONS

<table>
<thead>
<tr>
<th>SR.NO</th>
<th>INVESTIGATIONS</th>
<th>NUMBER OF PATIENTS</th>
<th>PERCENTAGE(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>ANEMIA (Hb &lt;10gm/dl)</td>
<td>10</td>
<td>20%</td>
</tr>
<tr>
<td>2.</td>
<td>S.CREAT (&lt;5mg/dl)</td>
<td>3</td>
<td>6%</td>
</tr>
<tr>
<td>3.</td>
<td>S.CREAT (&gt;5mg/dl)</td>
<td>47</td>
<td>94%</td>
</tr>
</tbody>
</table>

In my present study, 10 patients out of 50 had anemia, 3 patients had preoperative serum creatinine values less than 5mg/dl and 47 patients had serum creatinine level more than 5mg/dl.

Discussion-

1. Successful haemodialysis depends on the availability of safe, efficient, and durable access to the vascular tree. This can be provided by creation of an arteriovenous fistula, insertion of a synthetic vascular graft or insertion of a central venous catheter. Established haemodialysis vascular access is
associated with a number of important complications which can impact significantly on both the quality of life and survival of haemodialysis patients.

2. A functioning vascular access is the lifeline for patients requiring HD, but access-related complications, such as infection, vascular access failure, cannulation problems, and bleeding, are associated with increased morbidity, mortality, and health-related costs.\textsuperscript{40,41,42}

3. In study of Firdaus et al\textsuperscript{47} study of 150 patients for creation of AV-fistula in Chronic renal failure patients, 14(33.3\%) patients developed thrombosis, 13(30.95\%) had post-operative edema, 8(19.04\%) developed wound infection, 5(11.9\%) had ischemia due to steal phenomenon, 115(76.6\%) had patent fistulas while 35(23.33\%) had failure due to low patency rates and 2(4.76\%) had aneurysm.

In my present study of 50 patients of Chronic renal failure with creation of AV-fistula, no any thrombosis or ischemia due to steal phenomenon was reported after AV-fistula creation. 8(16\%) patients had failure due to low-patency rates, 2(4\%) had aneurysm, 3(6\%) developed wound infection, and 2(4\%) developed edema at operative site.

<table>
<thead>
<tr>
<th>TABLE-8- COMPARISION OF COMPLICATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>SR.NO</td>
</tr>
<tr>
<td>-------</td>
</tr>
<tr>
<td>1.</td>
</tr>
<tr>
<td>2.</td>
</tr>
<tr>
<td>3.</td>
</tr>
<tr>
<td>4.</td>
</tr>
<tr>
<td>5.</td>
</tr>
<tr>
<td>6.</td>
</tr>
</tbody>
</table>

In my present study, failure rate, wound infection, edema was less compared to Firdaus ‘s study but aneurysm formation was similar and no any post-operative thrombosis or ischemic steal phenomenon was noted in my study.

(4) Practices such as sterile barrier nursing, hand hygiene, use of antiseptic solutions such as chlorhexidine and removal of the catheter at the earliest point possible are widely established and reflected in national guidelines.\textsuperscript{46} The patients who developed edema were initially treated with topical corticosteroids, glycerine application, limb elevation, and heparin sodium and benzyl nicotinate ointment and resolved gradually.

(5) Arteriovenous fistula is the best conventional method for creating vascular access for patients with chronic renal failure. An efficient fistula should be available for use after its creation.

(6) End Stage Renal Disease represent the state of body in which regular dialysis is required according to the need of the body. For regular dialysis AV fistula is the best vascular option available.

(7) Out of 50 patients, where 42 (84\%) patients had well functioning AV fistula.

(9) In Our study of 50 patients, 8 (16\%) patients have nonfunctioning AV fistula, out of which 4 patients were diabetic and 2 patients had ischemic heart disease.

(10) Out of 50 patients, 26(52\%) patients were Male and 24(48\%) were female.

Conclusion and summary-

1) Creation of Arteriovenous fistula for haemodialysis is simple outpatient procedure.
2) In our study of creation of Arteriovenous fistula for Haemodialysis reveals following

- Arteriovenous fistula for haemodialysis has reasonably good success rate with fewer complications.
- Association with diabetes, ischaemic heart disease leads to higher failure rates.
- Adequate arterial and venous diameter required for successful creation of arteriovenous fistula.
- Complications of arteriovenous fistula creation if properly treated are not life threatening.
- Once fully functional, arteriovenous fistula can be used for dialysis for prolonged periods.
- Arteriovenous fistula creation is one of best vascular access option for dialysis in chronic renal failure patients.
REFERENCES:

40. Taylor MJ, Hanson CS, Casey JR, Craig JC, Harris D, Tong A. "You know your own fistula, it becomes a part of you".Patient perspectives on vascular access: A semistructured interview study. Hemodial Int. 2015.
47. Firdaus A Dekhaya’s prospective study of creation of AV-Fistula in chronic renal failure patients, July 15,2015.