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Vascular Access Surgery for Permanent Hemodialysis - A patient resource

This Document is created by Dr Vijayant Govinda Gupta, MCh Urology with the intent of helping CKD patients moving to hemodialysis to understand and better plan their vascular access.

It includes personal opinions and views gained through experience and are supported by evidence based science as far as possible. This resource is not meant to be a professional learning resource and is not to be applied by healthcare providers or caregivers without professional medical oversight.

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Kidney Failure – Types and common causes

Kidneys are two kidney bean (Rajma) shaped organs situated in the back region (retroperitoneum) that are connected directly to the major blood supply of the heart. They receive and filter the blood flowing through them of all toxic products created in the body due to life processes. Most important among them are wastes such as creatinine, urea and water. It converts all this into urine which is then passed out of the body. Water is essentially a waste, if there is no way to remove water, the body will swell up and the human body cannot survive. The kidney is very efficient at removal of waste water and can remove upto 50 litres of water if required, but most healthy human beings produce about 2 to 3 litres of urine per day.

Kidney failure (also called kidney disease) is a condition when the kidneys cannot take care of their filtration process. This cause build up of toxic metabolites in the body which becomes incompatible with life.

This kidney failure is also called renal failure or kidney disease. This condition can be either acute or chronic.

Acute Kidney Failure (ARF/AKD/AKI) is when the kidneys fail suddenly or unexpectedly. The medically defined is less than 6 months. This kind of failure is usually due to a sudden insult to the body, and if the offending insult is removed, chances of recovery are usually good.

Common causes of Acute Kidney Injury are Renal Stones, Obstruction, Infection, some offending drug or Cancer such as Myeloma.

Chronic Kidney Disease (CKD/CRF) is when the kidney failure is due to prolonged disease more than 6 months. The most common cause of Chronic Renal Failure in the world is Diabetes. Diabetes is like a termite, which eats away at the kidneys slowly and over years destroy the kidneys. Other common causes are Hypertension (High BP) and Old Age.

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Treatment modalities for Kidney Failure

Treatment of kidney failure is varied. In Acute kidney injury all effort is made to control the offending insult, and the patients may recover completely. But in CKD, it is essential to halt the progression of disease.

The following efforts may halt the progression of Chronic Kidney Disease (due to Diabetes)

1. Strict control of Blood Sugar
2. Maintain BP in the healthy range (<130 mm Hg)
3. Maintain healthy body weight
4. Regular Exercise – especially Isotonic exercises to increase muscle mass
5. Low Salt intake
6. Avoid Red Meat intake
7. Controlling Bad Cholesterol
8. Pharmacological management of CKD – Diuretics and Bicarbonate Supplementation (yet unproven)

There is as of now no treatment that can reverse kidney failure that is chronic.

Sometimes removing stones, treating infection, removing obstruction can improve the kidney function, but halting kidney failure is the best bet.

Once the kidneys fail, that is the GFR declines below 15 ml/min, the body is unable to filter the metabolic wastes and the patients will require some form of treatment. Either a Dialysis or Renal Transplant.

Dialysis – Dialysis is the artificial removal of body wastes via a machine or external appliance.

Renal Transplant – Renal Transplant is the process of taking a kidney from another human being and placing it inside the body of the patient to allow him a new kidney.

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What is GFR and how to calculate eGFR and cGFR?

GFR or Glomerular Filtration Rate is the speed with which the kidney is able to filter the toxic metabolites from blood. In normal human beings its above 120 ml/min. As the kidney is destroyed GFR falls, that is the filtration capacity is falling.

GFR decline is used to classify Chronic kidney Disease into stages

This GFR is calculated using formulas – these can be the Cockcroft Gault formula or the MDRD equation.

These usually take the patients serum creatinine into account. The various stage of CKD are given below in the figure.

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Hemodialysis

Hemodialysis is the procedure of filtering the blood of a patient of all toxic metabolites. In dialysis the patient is connected to a dialysis machine. There is an inflow and an outflow in the body. So blood flows out of the human body via a vein then enters the machine where the machine will dialyze and then clean the blood. After that the blood is flown back into the body via a vein. This process though life saving and efficient is not equivalent to the human kidney.

It has its disadvantages

1. With every dialysis the body loses some blood – can lead to anemia
2. Risk of infections such as HIV/HBV/HCV
3. Risk of fall in BP and Hypotension
4. High BP after every dialysis
5. Time spent in the dialysis room every third day
6. COST
7. Loss of Residual Renal Function – Usually even if a patient is on dialysis, the person will still produce some urine. Hemodialysis completely stops

all renal function causing the patient to control his fluid intake very very strictly.

For these reasons you should consider peritoneal dialysis. [Read here.](#)

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Can Kidney failure be reversed?

Like I mentioned earlier, there is no medicine or research molecule till today that can reverse CKD or CRF once it sets in. The only real option is to halt the disease progression. But if the injury is acute, then there may be some hope.

Patients with Diabetic Nephropathy may have acute insults like stone formation, infections, drugs, etc. If we remove stones, relieve obstruction, CKD may stabilize or even reverse.

This requires expert evaluation from a Nephrologist and a Urologist. Consult one who is qualified.

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Permanent vs Temporary Hemodialysis

Hemodialysis may be permanent or temporary. In AKI patients, the patients need support only during the period of acute insult and may require only 3-4 sessions of dialysis. Here a temporary option is valid.

But if the kidneys have failed due to diabetes and the eGFR has fallen below 15, then the dialysis will be required for life or the patient receives a renal transplant. Even if the transplant is done, the new graft or kidney may fail, and the patient may need dialysis again. So permanent dialysis requires a permanent solution or access.

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Methods of obtaining Access for Hemodialysis

For a successful hemodialysis to happen, blood need to be removed from the body, dialyzed and then returned to the body. This blood is obtained from a vein. This blood has to move at a very high flow, and thus any small vein cannot be used as it will not be able to take the speed of flow. For adequate flow through the machine vascular access or dialysis access can be taken in two ways Central Venous Catheters or AV Fistula. Central Venous catheters are placed in to the neck or in the groin. These areas have the biggest veins in the body. But central venous catheters are bad for permanent vascular access for reasons given below.

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What is an AV Fistula?

An AV fistula or Arteriovenous Fistula is a permanent form of vascular access procedure (dialysis access procedure) that creates a vein in the arm that is

1. High Callibre or has a wide lumen through which blood can flow easily
2. No valves – These veins have no valves preventing obstruction in flow
3. Easily visible or felt – for easy cannulation for dialysis
4. Heals easily after a puncture
5. Thick muscular walls to prevent rupture on high flow dialysis.

This is achieved by a phenomenon known as arterialization of a vein. In AV Fistula surgery, the surgeon artificially takes a small vein in the arm or wrist and joins it to an artery in the hand. The arterial system has very high flow blood because it directly comes from the heart. When this high pressure blood enters the vein, the usually thin and small vein over time will develop all the characteristics as described above.

Once the AV Fistula matures over a period of 4 6 weeks, the fistula can be used for hemodialysis any number of times.

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Disadvantages of Central Venous Catheters

Central venous catheters for hemodialysis, though life saving in the short term have several disadvantages. For this reason, global agencies have repeatedly stressed that in patients moving towards hemo dialysis need to plan ahead so that the use of these can be minimized or avoided all together.

The disadvantage of these catheters are

1. They are temporary – they will have to be replaced every 3 weeks
2. They are costly over a period of time
3. They can introduce infections that travel along them directly into blood
4. Central Venous Stenosis – These catheters by causing injury, can close the veins in which they are placed. This makes any av fistula surgery in the future impossible.
5. If placed in the veins in the groin, they can make transplant difficult if not impossible on that side.

EVEN IF THEY NEED TO BE PLACED, THEY SHOULD BE PLACED ON THE SIDE WHERE THE AV FISTULA SURGERY IS NOT BEING PLANNED

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Advantages of AV Fistula

AV Fistula is the vascular access of choice for permanent hemodialysis. This is because of the following reasons

1. It is a permanent solution – no need for repeated procedures
2. No need to carry any pipe or tubing with you all the time
3. 500 times less risk of infection than catheters
4. No risk of central venous stenosis
5. Freedom to stay near a dialysis centre, as fistula can be cannulated anywhere

6. Cheaper on the long run
7. New research has shown that early av fistula creation can slow down the progression of the disease.

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Disadvantages of AV Fistula

The reason why people hate an AV Fistula is before they have one. The fear of surgery keeps them delaying it until they go through the pain of inadequate central venous access and then find that they cannot have an av fistula and then they run from pillar to post to find a salvage procedure.

There is no real disadvantage and all major professional bodies now recommend that 80% of patients bound to reach hemodialysis get mature fistulas before they start dialysis.

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Distal Wrist AV Fistula

The most common and beneficial fistula is the distal wrist AV fistula. Every dialysis patient should consider the arm veins as vital real estate. If it is possible the distal most arteries and veins should be used. Distal would mean as near the wrist as possible because all fistulas ultimately have a life. At some point, your doctor may need to revise and make a fistula proximally or in other words move up the arm towards the elbow or higher.

The distal fistula is also called the "Radio Cephalic fistula", the "Snuffbox fistula" or the "Berscia-Cimino Fistula". This uses the artery and vein in the wrist to create the fistula. This fistula can be created in either arm, and usually the surgeons will prefer the non dominant arm, but there is no compulsion. It will always depend on the assessment of the arm, and the quality of veins available.

Sometimes in 10% of patients, a distal av fistula is not possible, and then the surgeon may primarily move onto a forearm fistula.

Sometimes if a radio cephalic fistula is not possible, and the patient is willing, and the surgeon is proficient, then a transposition AV fistula is possible. A dominant forearm vein can be removed and patched to the wrist and it works well.

But as far as possible, it is essential that all possible efforts are made to construct a distal fistula.

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Proximal Arm AV Fistula

In cases where the wrist veins are unsuitable and no transposition grafts can be done, the surgeon has an option to make a proximal fistula. In this surgery the vein chosen is in the forearm near the elbow and the fistula works in the arm.

Example could be a Radio Brachia artery fistula, a antecubetal vein and a brachial artery fistula, a basilic vein transposition or others.

These fistulas have better results and in some patients, it is recommended to directly move on to a proximal fistula.

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Grafts

Some patients due to many reasons will not have any suitable veins. Their veins may have been ruined by repeated cannulation, or are just too thin for surgery.

In these patients there are options of finding grafts or artificial tubes that can be brought to the arteries in the arm for construction of the fistula.

Grafts can be harvested from the legs or artificial ones made from Goretex or other newer products are available. These grafts provide good results, but are notorious for having high failure rates.

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Timing of AV Fistula surgery

Most patients suffering from kidney disease become aware of the fact that they will require some form of dialysis in the future. And they begin preparation well in time in terms of finding family support and creating financial resources.

But, one discussion Indian patients universally avoid is for the creation of an AV fistula. Reasons for this are many. Among them chief are

1. The feeling that they may never need dialysis – a state of denial
2. The feeling that they may get more time and they will get it done later
3. The feeling of fear of surgery which they feel is unnecessary
4. The feeling of ignorance – where they know they need it, but are too ignorant
5. Socio Cultural Economic factors – Family members, support groups or financial conditions may not permit
6. Lack of knowledge – Most patients are not aware of the dangers of central vein cannulation and difficult dialysis procedures that may follow.

It is the duty of every patient of CKD progressing towards dialysis to plan ahead. There are certain precautions that they should follow by default even if they are not planning to get a fistula constructed.

1. Get immunized for Hepatitis B, Influenza and Pneumonia
2. Prevent the use of any arm (especially the preselected arm) from any form of injury or needle puncture
3. No drug catheters or blood samples from the pre selected arm.

Apart from this the ideal time line for planning a Fistula is

1. CKD 3 (Serum Creatinine of 2.0 and GFR between 30 -60) – Meet a Urologist and get a doppler of the arm to select the arm and evaluate for adequate vein and artery diameter.

2. CKD 4 (Serum Creatinine of 3-4 and GFR below 30) – With discussion with a nephrologist, estimate time to progression to CKD 5. This is the best time to create a fistula as the surgery is easy, complications are minimal and the fistula get an adequate time to mature.
3. CKD 5 (GFR below 15) – Urgent indication to prepare a fistula before the patient progresses to Hemodialysis.
4. Hemodialysis started – This is the most terrible time to initiate the process as till the fistula matures the patient is obliged to keep a central venous catheter.

SO THE BEST TIME TO GET EVALUATED, PLAN AND CONSTRUCT AN ARTERIO VENOUS FISTULA IS WHEN THE PATIENT IS IN CKD 4 OR HAS A SERUM CREATININE BETWEEN 3 TO 4.

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Benefits of Early Surgery

There are many benefits of early fistula surgery as compared to constructing one after initiating Hemodialysis.

1. Planned surgery – patient gets time to plan and arrange finances, family support and other things.
2. Less complications – No issues of bleeding, need to plan dialysis etc
3. Better results
4. More time to allow the fistula to mature
5. And new studies suggest that an AV Fistula may actually delay the time to CKD progression.
6. Prevents complications associated with central venous cannulation

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Selection criteria for Fistula Creation

For a successful arteriovenous fistula surgery that can be used for hemodialysis, the following selection criteria are used.

1. Non dominant arm preferably
2. Good diameter veins and arteries
3. No atherosclerosis or blockage in the vein or artery
4. Valveless veins
5. Veins should be superficial (or easily seen) to be easily cannulated
6. No central venous stenosis
7. No history of prolonged dialysis from neck veins

Usually if all the criteria are met, chances of success are very very good.

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Success rates of AV fistula

If the surgery is done by a very competent surgeon, with excellent technique and the patient meets all the defined criteria, still the success rate of the fistula maturation is around 90%. 10% fistulas will still fail. There are many reasons discussed below.

Secondly whatever the success rate, 50% of fistulas will stop working by the end of two years. And 80% by the end of 3 years. The reasons are discussed below.

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Reasons for failure of AV Fistula

The reasons for Dialysis Access failure are many and are discussed below

1. Inflow Stenosis – The fistula never matures and there is inadequate flow in the fistula
2. Outflow stenosis – There is central vein narrowing due to past cannulation and repeated needle puncture
3. Diabetes and Hypertension
4. Inappropriate cannulation
5. Prolonged Dialysis
6. Old Age

7. Inappropriate Surgery or technique
8. Venous Thrombosis
9. Aneurysm due to wrong technique of punctures

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Complications of AV Fistula

AV fistulas and Dialysis Access are life saving and work well but they are prone to complications. These complications are many, but the two most important are

1. Thrombosis – After a long dialysis session, a clot may get stuck in the vein jamming it. It is an emergency and may not only ruin the fistula but may cause the arm to go bad.
2. Aneurysm – Repeated wrong punctures may weaken the wall of the fistula and cause the arm to swell. It is again an emergency and requires emergent surgery.

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Care of AV Fistula

Once the fistula is ready and matured, certain precautions can extend the life of your AV fistula and Dialysis access. These are

1. Keep hand clean and moisturized to prevent any infections
2. Get the fistula punctured by only trained technicians either by “Bulls Eye technique” or “3 point technique”
3. Post hemodialysis ensure that there is thrill and bruit
4. Regular checkup of the fistula
5. If fistula stops pulsating to rush to the emergency within 6 hours
6. Do not puncture the arm with the fistula ever
7. Keep moving and exercising the arm to keep the blood flowing

This fistula care can keep your fistula healthy for a long long time.

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Re surgery in case of AV Fistula failure

Any fistula is bound to fail after a number of uses. Most fistulas will close by 3 years. Re surgery in these cases is difficult and success rates are low. We can try to salvage the vein but it is usually difficult. But, it requires expertise.

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Cost of AV Fistula

AV Fistula surgery or Dialysis Access surgery is a one time investment. A well done surgery can provide you comfort from long term problems.

AV fistula surgery at my centre includes

1. Pre planning and assessment
2. Fistula care training
3. Anesthetic clearances
4. Doppler and Ultrasound assessment
5. Surgical Costs

You can write to me to discuss costs and pricing. Fistula surgery may be covered under some panels/TPA and insurances.

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My Credentials for AV Fistula surgery

I have the following training which allows me to provide fistula creation surgeries to you

1. S. from Maulana Azad Medical College where I learnt the basics of Fistula management
2. Senior Residency in Lok Nayak Hospital, New Delhi, where I helped and assisted in AV Fistula surgery.
3. Trained in Microsurgery with DR RCM Kaza at Maulana Azad Medical College

4. MCh Urology from PGIMER, Chandigarh where I learnt and managed AV Fistula complications including management of CKD patients
5. Certification in Vascular Access from ceMAST, Mumbai in Jan 2017 where I learnt the best global practices.

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What to expect for Vascular Access Surgery?

Dialysis access surgery or Fistula surgery is a daycare procedure unless time constraints or health condition demands otherwise. If done before initiation of hemodialysis usually the patient can go home the same day. If it is after hemo dialysis then because of surgical risks, it is important that the patient may need to stay at the hospital for a day to observe the wound.

The surgery is done under local anesthesia. The patient is awake during the procedure and only the operative area is made numb and usually there is no pain. During the surgery the patient may choose to hear light music according to the surgeons preference. The surgery is usually completely painless.

The surgery usually takes 90 minutes to 120 minutes depending on complexity. After the surgery the patient is observed for a few hours and can go home in the evening. Stitches are removed after 7 days.

The arm is kept under bandage and the patient is required to not move or twist it when sleeping for 1 day. Some light arm exercises are thought that the patient can do. He may need assistance in bathing and going to toilet if his main arm is operated for 2 to 3 days. Once bandage is removed after 48 hours, he can wet his arm.

Antibiotics and Painkillers are continued for 5 days. Usually the fistula is matured for use over a period of 6 weeks.

The patient is trained to hear, feel and touch his fistula at time of discharge and signs of concern are thought to him, and in case of any emergency is asked to report back to the emergency. Emergencies are usually very rare.

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