Dialysis Access Education

Kidneys remove waste from the blood. When the kidneys fail, they can no longer do this. Dialysis takes over to keep the blood clean. The principle of hemodialysis is simple: remove blood from the patient's circulation, filter it in the dialysis machine and then return the dialyzed blood to the patient's circulation.

There are two types of dialysis – Hemodialysis and Peritoneal Dialysis.

Hemodialysis is usually performed 3 times a week and takes about 3-5 hours. Two needles are inserted into your hemodialysis access, blood flows through one needle and connecting tube to an artificial kidney (dialyzer) where the blood is cleansed, then returned to your body through the second tube and needle.

Before hemodialysis is started, a way to access your bloodstream must be created. This access is meant to be permanent so that it can be reused for each dialysis session. The different types of access for hemodialysis are created during a surgical procedure and include the following:

- **Hemodialysis Catheter** – Though typically not used for permanent access, a hemodialysis catheter may be used temporarily if kidney disease has progressed quickly and other access has not been obtained. In this case, a catheter is placed in a vein in the neck (jugular vein), chest (subclavian vein), or leg (femoral vein). Dialysis catheters are also used for patients needing dialysis while their permanent access develops.
- **Arteriovenous fistula / graft** is created by connecting a vein to an artery (AV fistula or AVF) or by interposing a conduit, usually of synthetic material, between an artery and a vein (AV graft or AVG). Blood flows rapidly into the vein, enlarging it. This provides a high flow circuit, which may be percutaneously cannulated for hemodialysis access when sufficiently mature. A matured AVF outperforms AVG, in terms of higher patency rates, freedom from infection and decrease in maintenance costs.

Peritoneal Dialysis is a technique used to remove waste products from the blood through the instillation of fluid into the abdominal cavity. Fluid is placed into the abdominal cavity and left for several hours after which it is removed. The fluid removed contains both wastes and extra fluid from the body. The special fluid used in this process is instilled and subsequently removed through a:

- **Peritoneal Dialysis Catheter** – A special tube that is placed, during a short surgical procedure, into the abdomen which allows for the instillation and evacuation of fluid used in peritoneal dialysis. Placement of the catheter is usually done 10-14 days before dialysis starts.

  Some types of peritoneal dialysis catheters may be used immediately (acute-use catheters). However, because of a high risk of complications with prolonged use, these catheters are not commonly used. A peritoneal dialysis catheter typically lasts about 3 years before needing replaced.

Vascular access:

Order of preference for placement of vascular access in patients with kidney failure who will become hemodialysis dependent:

1. The nondominant arm is usually preferable for dialysis access placement and is usually evaluated first.

2. A forearm cephalic vein AVF (radial artery–cephalic vein), followed by an upper arm cephalic vein AVF (brachial artery–cephalic vein), is preferred.

3. If it is not possible to create either of these fistulae, access may be established using a transposed basilic vein fistula (brachial artery–basilic vein), or other AVF configuration.

4. If the vascular anatomy is not suitable for any AVF placement, a graft of synthetic material (eg, polytetrafluoroethylene [PTFE]) may be placed. A forearm loop graft (brachial artery to antecubital vein) is preferred over an upper arm straight graft (brachial artery to basilic vein). If no other upper extremity access is possible, an upper arm loop graft (axillary artery to axillary vein) may be placed if the anatomy is suitable.

5. Thigh grafts (superficial femoral artery to great saphenous vein or common femoral vein) are the next usual site for access placement.

6. Placement of an upper extremity AVF or an arm or thigh graft is preferred to catheter-based hemodialysis due to increased catheter infection rates and often lower catheter flow rates compared to a graft or fistula

Arteriovenous fistulae

The most common native fistula is the radio-cephalic aka Brescio-Cimino Shunt. The majority of stenosis in the radio-cephalic fistula are found at the anastomosis followed by stenosis in the venous outflow with average PSV of 200 cm/sec in the patent fistula and PSV of >350 cm/sec in flow reducing lesions. Located at the wrist, these are the preferred site to preserve central vasculature for future access sites. Stenosis can occur at the juncture of principal run-off vessels, i.e. juncture of cephalic and subclavian veins in brachio-cephalic native fistulas.

In contrast to grafts, thrombotic occlusions of AVFs often occur early because of inadequate flow resulting from small lumen of vessels or failure to dilate. For early diagnosis of access thrombosis, mainly postoperatively, indirect CDU parameters such as a triphasic Doppler waveform and low flow values at the access feeding artery give a rapid answer.

Straight and loop grafts

In contrast to the Brescio-Cimino fistulae, peak systolic velocities of <150 cm/sec are common in non-stenotic graft segments of both straight and loop interposition graft. With both the straight and loop grafts, stenosis are most often found at the venous anastomosis with outflow lesions following in frequency. Gore-Tex grafts may become infected.

With a loop graft (U shape), to differentiate between the arterial and venous sides of the access graft, gently compress the graft in the middle of the loop and check each side of the loop for an arterial pulsation. There will be pulsation on one side only and thus identify the arterial side, (inflow). There would not be any pulsation palpated during compression on the venous side

In PTFE grafts, thrombosis is primarily the result of progressive venous outflow stenosis.

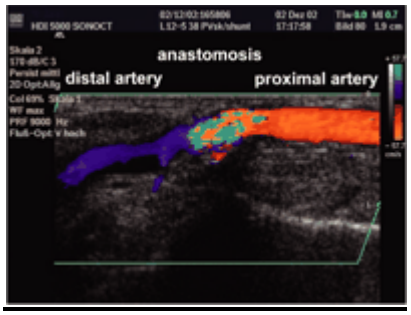
Thrills- AV access will typically have a thrill or vibration due to turbulent flow within the graft or vein. Changes in the thrill may indicate a problem with the graft. A weak thrill can denote poor arterial inflow or arterial stenosis. Feeling a pulse rather than a thrill may signify high-grade stenosis at the outflow of an AVF or at the venous anastomosis of an AVG. Furthermore, significant increase in venous pressure during dialysis can indicate a stenosis at the venous anastomosis or outflow vein.

Steal phenomenon - So to speak the newly created fistula steals blood, i.e. perfusion, from the distal extremity. Retrograde flow in the outflow radial artery of the mature fistula is present in 75-90% of patients, i.e. from the wrist to the fistula vein, effectively "stealing" blood from the ulnar artery via the palmar arch and can jeopardize adequate perfusion of the hand.

Steal phenomenon is particularly frequent in patients with forearm AVFs and in patients with prosthetic straight or loop grafts. Usually the steal phenomenon is clinically silent and the patient remains asymptomatic.

Steal syndrome is converted from a steal phenomenon when compensatory mechanisms to maintain peripheral arterial perfusion fails.

Stage I: Retrograde inflow of blood into the access during diastole without complaints is a frequent finding in arteriovenous (AV) fistulae and grafts and needs no intervention.
Stage II: Patients with pain on exercise or during dialysis, require permanent attention in order to early detect deterioration to stage III.
Stage III: Rest pain
Stage IV: Necrosis



Common problems with possible causes:

Problem: Native fistula not maturing
Cause: Inflow problem

Problem: Dialysis unit notes prolonged bleeding after removing dialysis needles.
Cause: Suggests central stenosis.

Problem: Dialysis unit notes increased venous pressures & high recirculation values.
Cause: Suggests central stenosis.

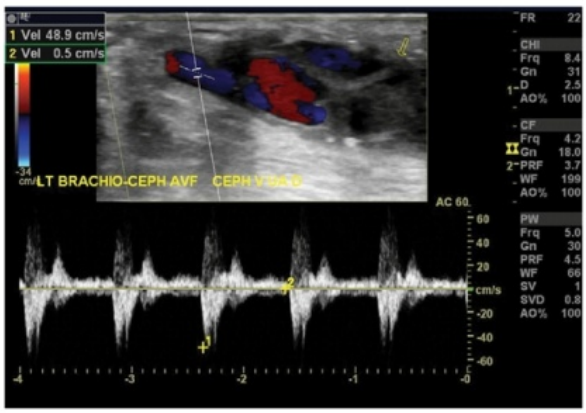
Problem: Dialysis unit notes difficulty with canulation
Cause: Low flow state due to inflow stenosis or deep fistula

Problem: Prominent superficial collaterals.
Cause: May suggest a central venous stenosis.

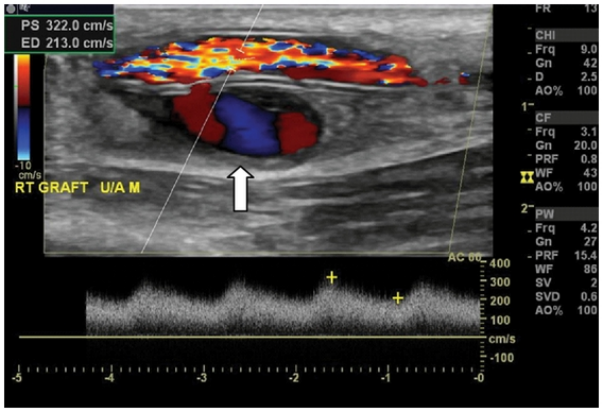
Problem: Swelling of extremity.
Cause: Suggests central stenosis

Problem: Large graft dilatation & associated soft tissue masses.
Cause: R/O aneurysm, pseudoaneurysm, hematoma (which can compress graft), perigraft collection-may represent sepsis & central stenosis.

Problem: Decreased flow volumes in absence of obstruction or stenosis in AV fistula.
Cause: Large branches can arise from native AV fistula and bring retrograde flow into hand, diminishing the flow in the access itself. Note, direction of flow when numerous branches are present.



This brachiocephalic fistula has thrombosed. Waveforms demonstrate a to-and-for flow characteristic indicative of a vessel with no outflow. Low PSV, the absence of color flow throughout the access, and the presence of echogenic material within the fistula are other findings compatible with access thrombosis.



This ultrasound demonstrates a pseudoaneurysm (PSA), denoted by the white arrow, arising from the posterior wall of an access graft, presumably as a consequence of through-and-through puncture. Color Doppler shows the classic swirling “yin-yang” pattern of blood flow typically seen in PSAs. Aneurysms and pseudoaneurysms usually develop at sites of vessel destruction after repeated canulation.

Reference:

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2) Colour Doppler ultrasound in dialysis access; http://ndt.oxfordjournals.org/content
3) Utility of Duplex Ultrasound for Evaluation of Hemodialysis Access and Selection for Intervention of Non-Maturing Conduits. Dennis Bandyk, MD