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Alternative Grafts for Brachioaxillary Hemodialysis access: Saphenous Vein Versus Synthetic Graft (Comparative Study)

Thesis Submitted for fulfilment of M.D. Degree in General Surgery.

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قَالُوا سُبْحَانَكَ لا عِلْمَ لَنَا إِلَّا مَا عَلَّمْتَنَا إِنَّكَ أَنْتَ الْعَلِيمُ الْحَكِيمُ

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Mohammed Alaa

List of Abbreviations

A.	**A**rterial.
ASA	**A**merican **s**ociety of **a**nesthesiologists
A.V.F.	**A**rterio **V**enous **F**istula.
A.V.G.	**A**rterio **V**enous **G**raft
B.B.A.V.F.	**B**rachio **B**asilic **A**rterio **V**enous **F**istula.
B.F.R.	**B**lood **F**low **R**ate.
B.U.N.	**B**lood **U**rea **N**itrogen.
C.T.	**C**omputed **T**omography.
D.O.Q.I.	**D**ialysis **O**utcome & **Q**uality **I**nitiatives.
E.S.R.D.	**E**nd **S**tage **R**enal **D**isease.
G.S.V.	**G**reat **S**aphenous **V**ein
H.D.	**H**emo-**D**ialysis.
H.F.	**H**eart **F**ailure.
IH	**I**ntimal **H**yperplasia
I.M.N.	**I**schemic **M**ono **N**europathy.
M.R.A.	**M**agnetic **R**esonance **A**ngiography.
O.V.PII	**O**mniflow **V**ascular **P**rothesis II
P.I.C.C.	**P**eripherally **I**nserted **C**entral **C**atheters.
P.S.F.	**P**eak **S**ystolic **F**requency.
P.T.F.E.	**P**oly-**T**etra-**F**luoro-**E**thylene.
P-Value	**P**ropability **V**alue.
R.C.A.V.F.	**R**adio **C**ephalic **A**rterio **V**enous **F**istula.
S.D.	**S**tandard **D**eviation.
S.V.C.	**S**uperior **V**ena **C**ava.
V.	**V**enous
V.A	**V**ascular **a**ccess

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Introduction

An increasing number of patients with chronic kidney disease depend on hemodialysis and maintenance of functional vascular access is a determining factor of successful hemodialysis.[1] Optimal access with an autologous arteriovenous fistula (AVF) offers a safe approach to the patient, provides appropriate flow for hemodialysis, is associated with low rates of complications and mortality and involves lower costs. [2]

The first-choice access for upper limbs is a radiocephalic AVF, because these are easily constructed and have been associated with few complications, while brachiocephalic AVFs and other autologous veins are good secondary choices. [3]

However, in many patients it is impossible to use upper-limb autologous veins for several reasons, including individual abnormalities of arteriovenous anatomy, failure of previous transposition fistulae, degenerative processes resulting from the underlying disease, excessive previous punctures of these veins, and atherosclerotic processes inherent to diabetes or advanced age. [4]

Alternative techniques using central venous catheters have been developed for situations in which autologous AVF is impossible. However, in addition to the very high costs involved in maintaining these types of access, they are also associated with high rates of complications, resulting in frequent hospital admissions and additional morbidity among patients with chronic kidney disease who require hemodialysis. [5]

Other alternative techniques include biological or prosthetic grafts. The most common locations used for this procedure is the upper arm bridging the brachial artery to the axillary vein. Grafts located in the groin looped between the superficial femoral artery and proximal saphenous vein are very dangerous; as infection is a common complication in that area and if it occurs it can seriously endanger the life of the limb and the life of the patient as well. ***(6)***

Both saphenous vein (SV) and expanded polytetrafluoroethylene (PTFE) grafts were proposed as options and exhibited good short-term results in terms of patency. However, both were associated with important complications (infection, thrombosis, seroma formation, aneurysm and arterial ischemia) and not infrequent occlusions caused by thrombosis and/or myointimal hyperplasia, leading to excessive morbidity and elevated costs. ***(7)***

Since 2006, it has been proposed that using heparin-bonded PTFE grafts could reduce the incidence rates of early thrombosis and late myointimal hyperplasia. Comparative studies have already shown that such grafts offer higher patency rates in lower limbs, when compared to standard PTFE grafts. ***(8)*** However, the primary patency of heparin-bonded PTFE grafts in lower limbs was still inferior to the primary patency achieved with autologous GSV grafts. ***(9)***

Great saphenous vein graft could be the first choice in those patients with consumed or unsuitable upper limb veins especially in developing countries with limited supply of PTFE due to economic reasons and high rate of infection. ***(10)***

Aim of work

The aim of this study is to compare great saphenous graft and polytetrtafluroethelene grafts used for brachio-axillary access in hemodialysis patients in terms of their patency and complications rates.

Chapter 1

Anatomy of vessels used for vascular access in hemodialysis patients

Anatomy of great saphenous vein

Veins of the lower extremity are subdivided, like those of the upper limb, into two sets, superficial and deep; the superficial veins are placed beneath the integument between the two layers of superficial fascia; the deep veins accompany the arteries. Both sets of veins are provided with valves, which are more numerous in the deep than in the superficial set. Valves are also more numerous in the veins of the lower than in those of the upper limb. The superficial veins of the lower extremity are the great and small saphenous veins and their tributaries. [(11)]

On the dorsum of the foot the dorsal digital veins receive, in the clefts between the toes, the intercapitular veins from the plantar cutaneous venous arch and join to form short common digital veins which unite across the distal ends of the metatarsal bones in a dorsal venous arch. Proximal to this arch is an irregular venous net-work which receives tributaries from the deep veins and is joined at the sides of the foot by a medial and a lateral marginal vein, formed mainly by the union of branches from the superficial parts of the sole of the foot**.** On the sole of the foot the superficial veins form a plantar cutaneous venous arch which extends across the roots of the toes and opens at the sides of the foot into the medial and lateral marginal veins. Proximal to this arch is a plantar cutaneous venous net-work which is especially dense in the fat beneath the heel; this net-work communicates with the cutaneous venous arch and with the deep veins, but is chiefly drained into the medial and lateral marginal veins. [(11)]

The great saphenous vein (GSV), previously also called the long saphenous vein, is a large, subcutaneous, superficial vein of the lower limb. It is the longest vein in the body running along the length of the lower limb. The terms

"safaina" (Greek, meaning "manifest," "to be clearly seen") and "el safin" (Arabic,meaning "hidden/concealed") have both been claimed as the origin for the word saphenous. [12]

GSV originates from where the dorsal vein of the first digit (the big toe) merges with the dorsal venous arch of the foot at the medial aspect. After passing anterior to anterior edge of the medial malleolus (first constant anatomical landmark), it runs up the medial side of the leg where it is accompanied by the leg branch of the saphenous nerve. This anatomical relation obviously carries a risk of sensory disorders following stripping. At the knee, it runs over the posterior border of the medial epicondyle of the femur bone (second constant anatomical land mark).). It then travels superficially over the medial region of the thigh, remaining parallel to the medial edge of the sartorius muscle. [12]

Two nervous structures accompany the long saphenous vein: the accessory nerve of the medial saphenous nerve and the anterior branch of the medial musculocutaneous nerve. In the femoral triangle, the long saphenous vein forms an arch as it penetrates into the depth of the thigh. It perforates the cribriform fascia immediately above Allan Burn's ligament, which actually corresponds to a reinforcement or fold of the cribriform fascia. The arch of the long saphenous vein then opens onto the anterior surface of the femoral vein 4 centimeters below the inguinal ligament (third constant anatomical landmark) as shown in figure 1. [11]

Its most immediate relations at this level are 1) Lymphatic: The saphenofemoral junction may be in contact with a lymph node situated in its concavity or may be surrounded by 4 groups of lymph nodes: superolateral, superomedial, inferolateral and inferomedial. 2) Arterial: The deep external pudendal artery, branch of the external iliac artery, often travels through the concavity of the saphenofemoral junction. Exceptionally, in case of high femoral

arterial bifurcation, the profunda femoris artery may lie adjacent to the saphenofemoral junction. These two particular features must be taken into account to avoid damaging the artery during dissection. The purpose of the great vein is delivery of blood from the ankle, lower leg, and thigh to the femoral vein, which is the main deep vein for the leg. Along its length are 10 to 20 one-way valves that keep the blood from flowing back toward the foot. Varicose veins occur when one or more valves stop working, creating distended areas where blood has backed up into smaller veins just under the surface of the skin. [(12)]

At the ankle it receives branches from the sole of the foot through the medial marginal vein; in the lower leg it communicates by perforator veins (Cockett perforators) with the anterior and posterior tibial veins and receives many cutaneous veins; near the knee it communicates with the femoral vein by the Boyd perforator, in the thigh it communicates with the femoral vein by perforator veins (Dodd perforator) and receives numerous tributaries; those from the medial and posterior parts of the thigh such as anterolateral and posteromedial veins, frequently unite to form a large accessory saphenous vein which joins the main vein near the sapheno-femoral junction. Near the fossa ovalis it is joined by the superficial epigastric, superficial iliac circumflex, and superficial external pudendal veins. The thoracoepigastric vein runs along the lateral aspect of the trunk between the superficial epigastric vein below and the lateral thoracic vein above and establishes an important communication between the femoral vein and the axillary vein. [(13)]

The vein is often removed by vascular surgeons and used for auto transplantation in coronary artery bypass operations, when arterial grafts are not available or many grafts are required, such as in a triple bypass or quadruple bypass. The great saphenous vein is the conduit of choice for vascular surgeons, when available, for doing peripheral arterial bypass operations because it has

superior long-term patency compared to synthetic grafts. It is used in situ (in place), after tying off smaller tributaries and stripping the valves with a device called LeMaitre's valvulotome. [14]

Criteria of good saphenous vein for grafting include that it should be patent, healthy (not fibrotic), 3 mm or more in caliber by duplex study with no history of DVT or thrombophlebitis. [14]

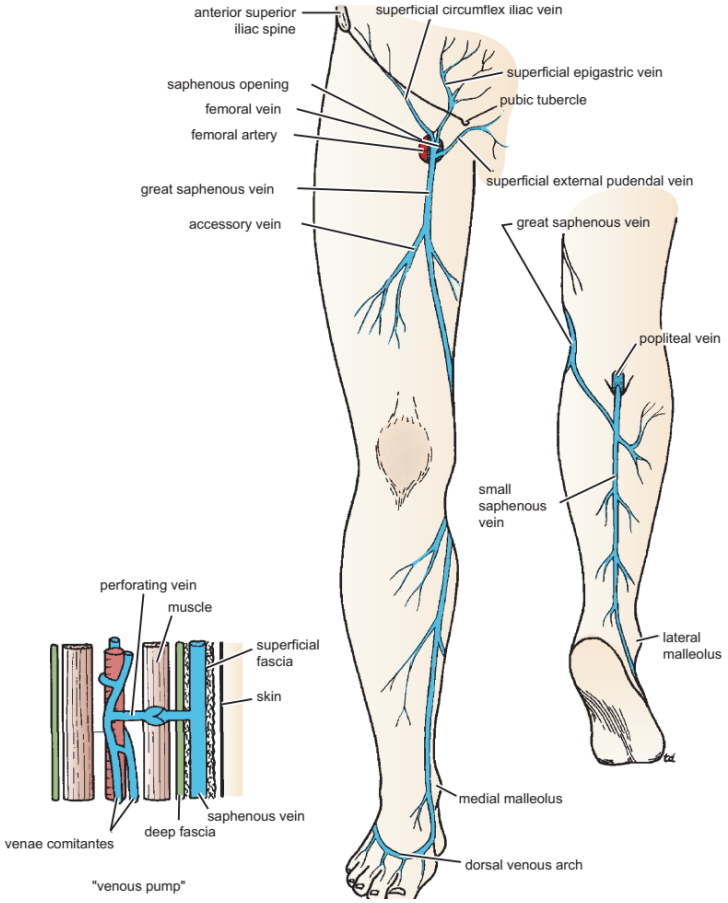


Fig (1): Superfcial veins of the right lower limb [11]

Anatomy of upper limb vessels used for brachioaxillary hemodialysis access

Brachial Artery begins at the lower border of the teres major muscle as a continuation of the axillary artery. It provides the main arterial supply to the arm. It terminates opposite the neck of the radius by dividing into the radial and ulnar arteries.It is related to 1) anteriorly: The vessel is superficial and is overlapped from the lateral side by the coracobrachialis and biceps. The medial cutaneous nerve of the forearm lies in front of the upper part; the median nerve crosses its middle part; and the bicipital aponeurosis crosses its lower part. 2)Posteriorly: The artery lies on the triceps, the coracobrachialis insertion, and the brachialis.3) Medially: The ulnar nerve and the basilic vein in the upper part of the arm; in the lower part of the arm, the median nerve lies on its medial side. 4)Laterally: The median nerve and the coracobrachialis and biceps muscles above; the tendon of the biceps lies lateral to the artery in the lower part of its course. **(15)**

Its branches include muscular branches to the anterior compartment of the upper arm ,the nutrient artery to the humerus,the profunda artery arises near the beginning of the brachial artery and follows the radial nerve into the spiral groove of the humerus ,the superior ulnar collateral artery arises near the middle of the upper arm and follows the ulnar nerve, the inferior ulnar collateral artery arises near the termination of the artery and takes part in the anastomosis around the elbow joint. **(15)**

The brachial veins are venae comitantes of the brachial artery in the arm proper. Their course is that of the brachial artery (in reverse): they begin where radial veins and ulnar veins join (corresponding to the bifurcation of the brachial artery). They end at the inferior border of the teres major muscle. At this point, the brachial veins join the basilic vein to form the axillary vein.The brachial veins also have small tributaries that drain the muscles of the upper arm, such as biceps brachii muscle and triceps brachii muscle**.** **(11)**

The axillary artery begins at the lateral border of the 1st rib as a continuation of the subclavian and ends at the lower border of the teres major muscle, where it continues as the brachial artery. Throughout its course, the artery is closely related to the cords of the brachial plexus and their branches and is enclosed with them in a connective tissue sheath called the axillary sheath. If this sheath is traced upward into the root of the neck, it is seen to be continuous with the prevertebral fascia.The pectoralis minor muscle crosses in front of the axillary artery and divides it into three parts**.** [(12)]

Branches of axillary artery include: the first part gives the highest thoracic artery which is small and runs along the upper border of the pectoralis minor. From the second part arise the thoracoacromial artery immediately divides into terminal branches, the lateral thoracic artery which runs along the lower border of the pectoralis minor. The third part gives the subscapular artery which runs along the lower border of the subscapularis muscle, the anterior and posterior circumflex humeral arteries wind around the front and the back of the surgical neck of the humerus, respectively. [(11)]

The axillary vein is formed at the lower border of the teres major muscle by the union of the venae comitantes of the brachial artery and the basilic vein. It runs upward on the medial side of the axillary artery and ends at the lateral border of the 1st rib by becoming the subclavian vein. The vein receives tributaries, which correspond to the branches of the axillary artery, and the cephalic vein. [(15)]

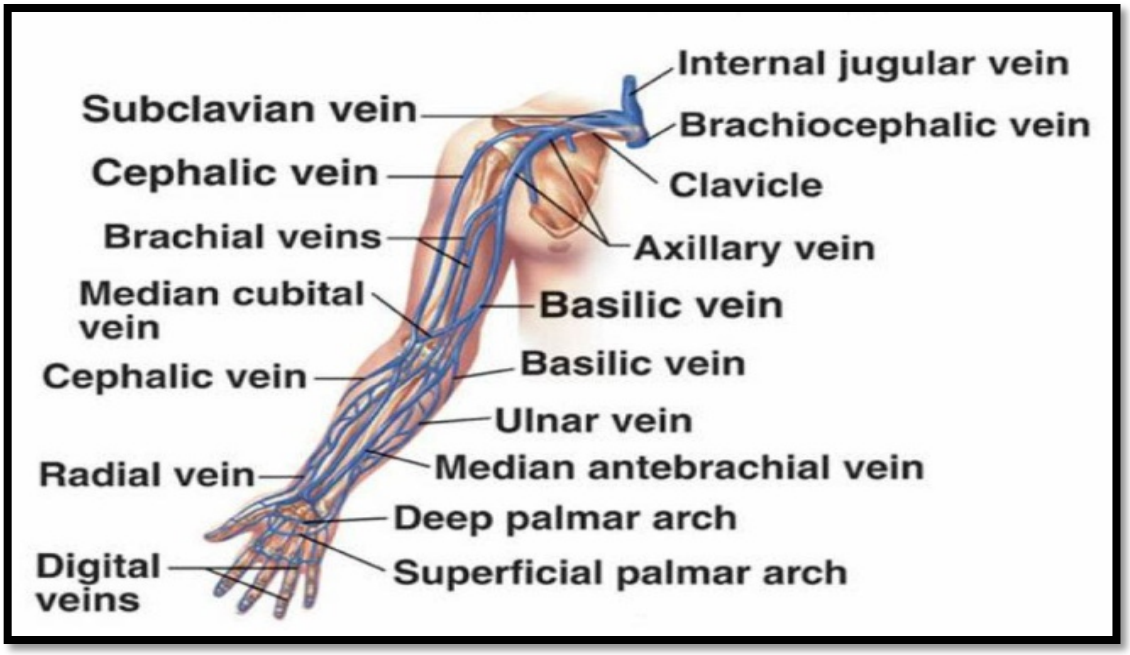


Fig (2): Venous anatomy of the right upper extremity [15]

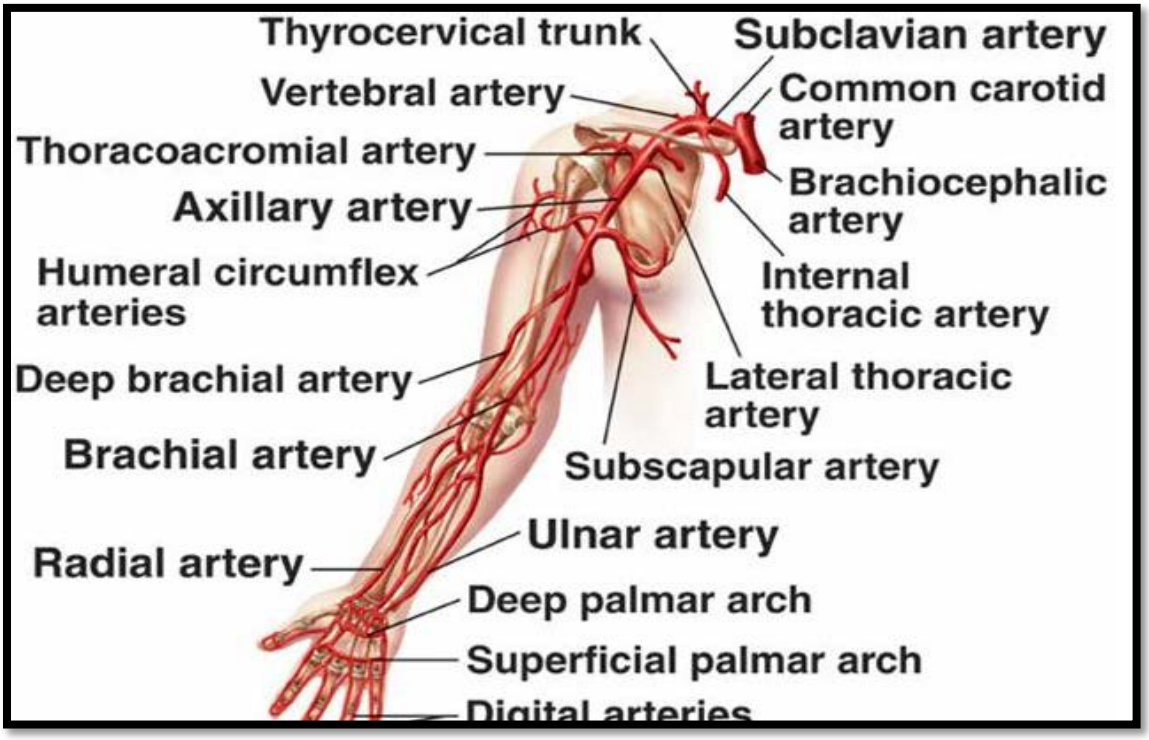


Fig (3): Arterial anatomy of the right upper extremity [15]

Chapter 2

Different types of vascular Access for Haemodialysis

Vascular access remains the Achilles heel of modern dialysis. Two factors related to vascular access influence dialysis efficiency: (a) recirculation, which is influenced by the quality of the vascular bed from which the access is drawn and: (b) the dialyzer flow rates. Vascular access in patients with renal failure can be either temporary or permanent. [16]

1- **Temporary access** (Percutaneous insertion of a central venous catheters (Mahurkar) into a large vein (Femoral, subclavian or internal jugular)):

is used for periods ranging from several hours to several weeks: The major indications for venous catheterization in the renal failure patient is the need for temporary vascular access for hemodialysis. Examples include. Acute renal failure requiring hemodialysis, chronic renal failure patient without available permanent access, end- stage renal disease not previously diagnosed, sudden failure of an established vascular access in a patient on chronic dialysis, and the inability to continue maintenance peritoneal dialysis because of the development of peritonitis or the need for intra- abdominal surgery. [16]

Complications of non-tunneled dialysis catheter insertion may be acute complications as: Arterial puncture, pneumothorax, hemothorax, air embolism arrhythmia. Subacute complications include Infection: Non tunneled dialysis catheters should not be left in-situ for more than 1 week as they have a higher risk of infection compared to tunneled dialysis catheters. In the event of infection, the patient should be treated with broad spectrum antibiotics and the non-tunneled dialysis catheter should be removed. Poor flow is also a complication in which

thrombolysis with tPA shouldn't be attempted. The appropriate treatment is to adjust it under fluoroscopy or place a new catheter over a guide wire**.** [17]

Fig (4): Temporary dialysis catheter [17]

2- Permanent access are methods that allow vascular access for months to years and include subcutaneous anastomosis of an extremity artery to a nearby vein (arteriovenous fistula), subcutaneous interposition of a tube graft between an extremity artery and vein (arteriovenous graft) and implantation of cuffed double lumen silicon elastomer catheter (e.g permacath device) into an internal jugular vein. [18]

A- Primary AV fistula: The primary or autogenous AV fistulas are probably the optimal choice in patients who have end- stage renal disease and require repeated hemodialysis. They have a low infection rate, are capable of supplying blood well in excess of the 400 ml/min required for dialysis and, once established, are less prone to thrombosis even at low flow rates caused by hypotension or rapid ultra-filtration. [19]

Distal arteriovenous fistulas:

Forearm fistulas may be fashioned by direct anastomosis of either the radial or ulnar arteries to a suitable adjacent vein. Distal fistulas have a higher primary failure rate (7-27%) than more proximal fistulas or polytetra fluoroethylene (PTFE) grafts, primarily because of thrombosis or failure to develop studies with duplex ultrasound on the influence of the vessel size on subsequent patency have shown that success is significantly more likely (8.3% primary failure) if the artery diameter is > 2 mm and the vien diameter is > 2.5 mm. [16]

The most commonly used primary fistula is the Brescia – Cimino wrist fistula, using the radial artery and the cephalic vein in the distal part of the patient nondominant forearm. It can last as long as 20 years with appropriate care. [20]

Patency of the cephalic vein and of the radial and ulnar arteries is tested using a tourniquet, palpation, and the Allen test. The Allen test is performed as follows:The patient is asked to clench both fists tightly for 1 minute at the same time, Pressure is applied over both radial arteries simultaneously so as to occlude them. Then, the patient then opens the fingers of both hands rapidly, and the examiner compares the colour of both. The initial pallor should be replaced quickly by rubor. The test may be repeated, this time occluding the ulnar arteries. [21]

A variety of anastomosis have been used, including side artery to side vein, end artery to side vein, side artery to end vein, and end artery to end vein. The side- to – side anastomosis results in increased blood flow on the expense of increased venous hypertension, which is correctable by ligation of te vein distal to the anastomosis. The end – to end anastomosis may be associated with a higher initial thrombosis rate due to the absence of collateral vessels and has the lowest fistula flow but it produces the least distal arterial steal and venous hypertension. [16]

Most surgeons prefer the end to side anastomosis because it gives less vascular complication and high proximal flow with minimal distal venous hypertension. [19]

After the fistula is created, it must be allowed to mature, which requires enlargement of the involved veins until they can be reached percutaneously. The advantages of primary AV fistulas are: long life span, decreased risk of infection, and high dialyzer flow rates. A disadvantage is that primary AV fistula cannot be used until vein maturation, which takes up to 93 days. In addition, vein maturation may be problematic and is not universally successful. The primary success rate of nealy 93% and one-year patency rate is approximately 82% if the fistula can be constructed. [19]

Ulnar fistulas were also created successfully in patients in whom a classic radial – cephalic fistula had failed, but ulnar fistulas have a shorter survival rate than radial – cephalic shunts. Access to the basilica vein is difficult, as this vessel is mobile, thin – walled and very spastic, which leads to difficulties of cannulation during the first dialysis sessions and to a higher failure rate during the first 6 months of use. [22]

However, the limiting step in primary AV fistula creation is usually inadequate venous anatomy to support the access flow. In these difficult patients, the arm offers an excellent site for either an autogenous fistula or a prosthetic shunt because of the relatively unharmed portion of the upper cephalic vein or the protected location of the basilic and brachial veins in most individuals. [23]

Proximal arteriovenous fistulas:

Proximal autogenous arteriovenous fistulas are formed at the ante- cubital crease by anastomosis of either the cephalic, median cubital (cephalic) or basilica veins to the brachial artery. Indications for primary fistula at this site include diseased distal arteries, occluded forearm veins or as secondary procedure following failure of a distal fistula. The disadvantage of using the brachial artery is that excessive fistula flow. Will result in steal from both the radial and ulnar arteries rendering the hand ischemic the arteriotomy should be limited to 5-6 mm in length. [(21)]

Brachio – basilica fistula : renewed interest in Brachio – basilica fistula has occurred since the release of the national kidney foundation – Dialysis outcomes Quality initiative (NKF – DOQ1) Guidelines because it is an alternative method to achieve an upper arm fistula in patients who cannot achieve a functional brachiocephalic fistula, also it is increasing in popularity as an alternative to prosthetic grafts. The basilica vein by virtue of its short subcutaneous path before entering the deep fascia rarely has suffered iatrogenic damage and its large capacitance is capable of sustaining high flow rates. The basilica vein is becoming larger with each tributary if the vein 10 mm in diameter near the axilla, that segment can accommodate up to 16 times more blood flow than can the 5mm segment near the anastomosis (by poiseuilles law, flow is proportional to the fourth power of the radius or diameter of the vessel) thus, this conical shape reduces jet flow, turbulence, intimal hyperplasia and stenosis. [(24)]

Brachio – basilic fistula provide cumulative patency equivalent to upper arm grafts and brachio cephalic fistula. They are less likely to thrombose and become infected than upper arm grafts. Compared with brachiocephalic fistula, they are more likely to mature but are at increased risk of thrombosis after maturation.

Brachio- basilica fistulas should be considered before placing an upper arm graft for patients that cannot achieve a functional brachio- cephalic fistula. [25]

The procedure is similar to formation of a brachiocephalic fistulas expect the proximal median cubital vein is anastomosed to the brachial artery. The short subcutaneaous segment is only suitable for single needle dialysis. the remainder lies under the deep fascia alongside the neuro – vascular bundle too deep for safe needing the classical one stage- management is for the vein to be mobilized throughout its length. [22]

The two – stage procedure is initially to form the arterivenous fistula in the usual manner and leave the vein to arterialize for about 6 weeks. The second stage involves mobilization of 12-15 cm of the vein up towards the axilla and transposing it in continuity in a more anterior and superficial plan. The deep fascia is closed underneath it to prevent retraction. [16]

The primary success rate of 94% similler to those reported by others which range from 88 to 95 percent the cumulative secondary patency rate for BBAVF 37.53 and 43 percent at 1.2 and 3 years respectively. [26]

The use of basilica vein for construction of the fistulas was considered unsafe because, its course is parallel to that of the brachial artery and repeated punctures is difficult with the risk of arterial injury but then it is been considered safe for creation of brachio-basilic arteriovenous fistula by transposition of basilica vein. [27]

B- Arteriovenous graft:

Native fistulas are preferable to synthetic grafts because of longer survival and a lower complication rate; however, not all patients have suitable anatomy to allow creation of an arteriovenous (AV) fistula. The vascular community continues to search for the ideal graft. That will allow early cannulation and avoid temporary central venous catheters. [28]

This technique involves placing a graft between an artery, usually the brachial artery in the ante-cubital fossa, and a vein. If the vein in the forearm then the graft will form a loop and if the vein is in the upper arm the graft will be straight. [28]

Types of grafts include:1-saphenous vein autologous grafts: readily available and inexpensive these grafts require a delay of about 6 weeks before the vein becomes suitable for cannulation,2-Synthetic polythene: polytetrafluoroethylene (PTFE) grafts. It is the most commonly used because of ease of handling, tissue inertness, and acceptable long-term patency. 3-Other types as -Bovine carotid artery heterograft, Human umbilical cord vein graft,Sparks mandril prosthesis.[16]

Human umbilical cord vein grafts and PTFE grafts have superiority over bovine heterografts. The most common initial site of arteriovenous graft placement is the non-dominant forearm from the radial artery at the wrist to the basilica vein. A common alternative is the loop graft from the brachial artery to the basilica vein. The anastomosis in both instances is made between the end of the graft and the side of the vein or artery. Grafts can also be placed in the upper arm or even in the thigh, although with a higher associated complication rate. [28]

Autogenous venous graft is not commonly used nowadays because it needs a separate incision, low patency rates, difficulty to puncture these grafts, increase incidence of aneurysmal formation and the patient is deprived from the vein availability for future vascular procedures. [22]

Arteriovenous grafts are usually placed in the operating room under regional anaesthesia, postoperative care is by keeping the extremity elevated for several days, and graft function is checked regularly by assessing for venous pulsation, thrill, and bruit. A standard-wall 6-mm expanded PTFE (ePTFE) material is of choice for prosthetic access grafts. Variations in the standard ePTFE graft include

thin-walled, extended stretch, external rings, various tapered configurations, and heparin coating. These are all meant to ease handling, provide external support, and improve patency rates. To date, there is only minimal evidence that any of these variations improve long-term results; therefore, use of these variations remains a matter of surgeon preference**.** [28]

Standard-wall grafts can be cannulated as early as 2 weeks; to improve this time further there has been recent development of early cannulation prosthetic grafts (Acuseal, W.L. Gore, Flagstaff, Arizona; Flixene Maquet-Atrium Medical, Rastatt Germany; and Vectra Bard, Covington, Georgia). They are generally constructed in three layers, with an elastomeric membrane sandwiched in between two layers of ePTFE material. This configuration hinders suture-line and dialysis needle bleeding, allowing for early cannulation reportedly as soon as 24 hours from implantation and thus offering the potential for either avoidance or early removal of short- and long-term dialysis catheters. Mean cannulation times have been reported in the literature from 2 to 15 days with minimal hematoma incidence; longer cannulation times were noted to be due to either surgeon or patient preference. Similar to other variations of prosthetic accesses, there is minimal evidence that this variation improves long-term results. Therefore, use of this variation remains a matter of surgeon preference. [16]

Both needles are placed into the graft. The arterial needle is inserted in the part of the graft closer to the arterial anastomosis but at lesat 3 cm away from the anastomosis site. The venous needle is inserted at least 5 cm away from te anastomosis site near the venous side. [29]

C- silicone dual – lumen catheter with Dacron cuff (permecath):

The silicon dual – lumen catheter with Dacron cuff is surgically implanted in a large vein via the internal jugular vein or femoral vein. Subclavian veins

should not be used for catheter placement as they are associated with an unacceptably high incidence of stenosis, which would compromise future upper limb AV access placement. The growth of connective tissue at the cuff greatly lowers the incidence of infection this catheter is indicated in children, diabetic patients, patients who are morbidly obese, patients in whom other forms of permanent access have failed. **(26)**

Numerous modifications were done to satisfy the requirements of high flow rates and minimal recirculation. The modifications fall into four general categories:1)Split Tip :Split-tip catheters have a double-lumen, single-body configuration in the midbody but separate into two distinct distal tips, each with side holes in all directions .2)Step Tip :The staggered-tip or step-tip catheter is a double-lumen, single body catheter with the venous limb extending at least 2.5 cm beyond the inflow tip.3)Dual Catheter: The dual catheter design consists of two completely separate catheters that can be inserted in two different locations 4)Symmetric Tip: The Tal Palindrome (Covidien, Mansfield, Mass) is the only catheter that has a symmetric tip design with equal length of arterial and venous limbs and biased spiral ports. The design of the ports allows inflow to occur through the most proximal portion of the port and outflow to occur as a jet directed away from the catheter tip. **(30)**

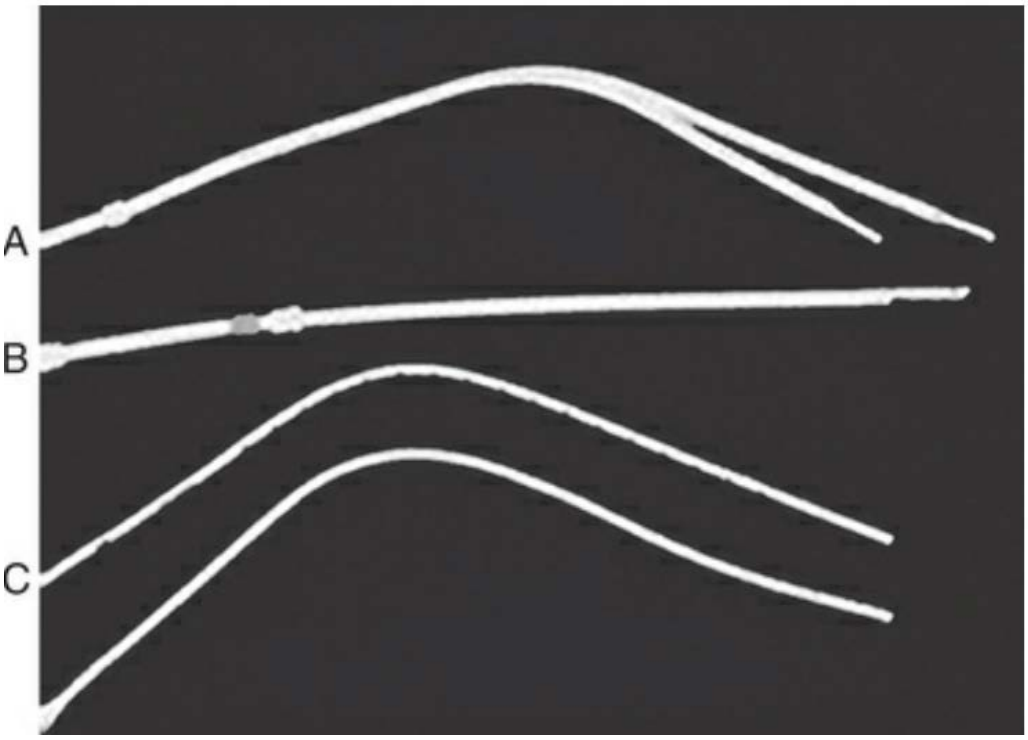


Fig (5) Types of tunneled hemodialysis catheters: split-tip catheter (A), staggered-tip or step tip catheter (B), and dual catheter (C) [30]

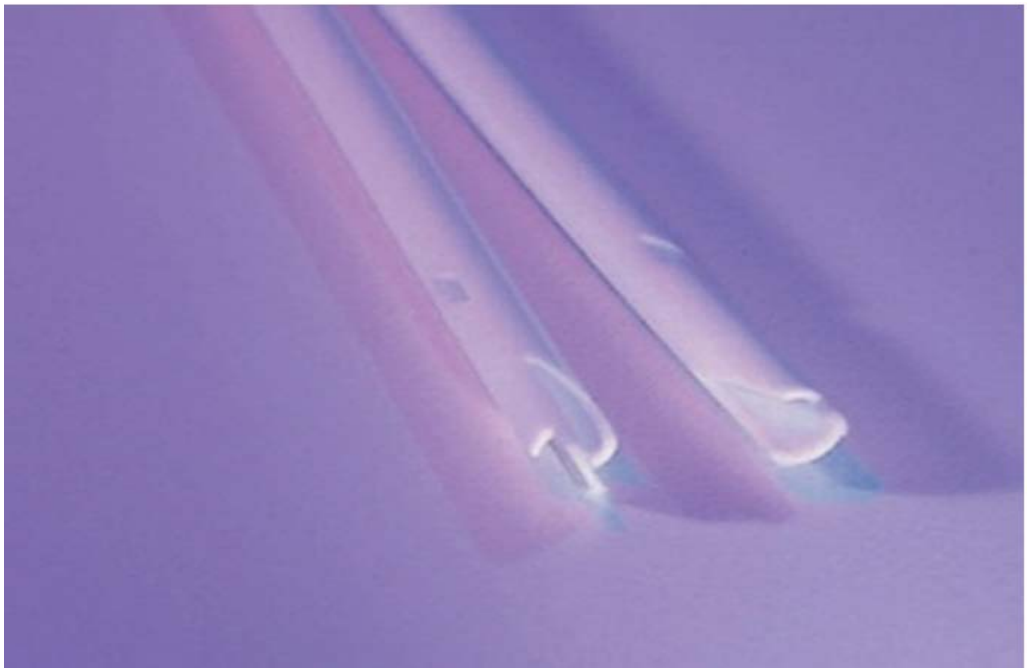


Fig (6): Tal Palinderome catheter [30]

Failure to place the central line and arterial puncture were the most common mechanical complications, followed by pneumothorax. Other complications include hemothorax, wire embolism, cardiac arrhythmias, cardiac perforation, thoracic duct laceration, brachial plexus injury. Long term complications include catheter occlusion, catheter embolism, air embolism. **(31)**

For patients whose options for an upper extremity vascular access are precluded by a central venous stenosis or occlusion, the hemodialysis reliable outflow (HeRO) device (Hemosphere, Inc., Minneapolis, Minnesota) is a reasonable alternative to a lower extremity access or tunneled dialysis catheter. The HeRO device is composed of two components: a graft component, which is a 6-mm PTFE graft with a titanium coupler at one end, and a venous outflow component, which is a 19-Fr silicone catheter reinforced with a nitinol braid to prevent kinking. The graft component is anastomosed to an artery such as the brachial artery and is tunneled subcutaneously as a standard prosthetic AV access. The venous outflow component does not require a venous anastomosis but rather is percutaneously placed into the right atrium via the internal jugular or subclavian vein. The graft and venous outflow components are tunneled subcutaneously to a counter incision in the deltopectoral groove, where they are connected with a titanium coupler. **(32)**

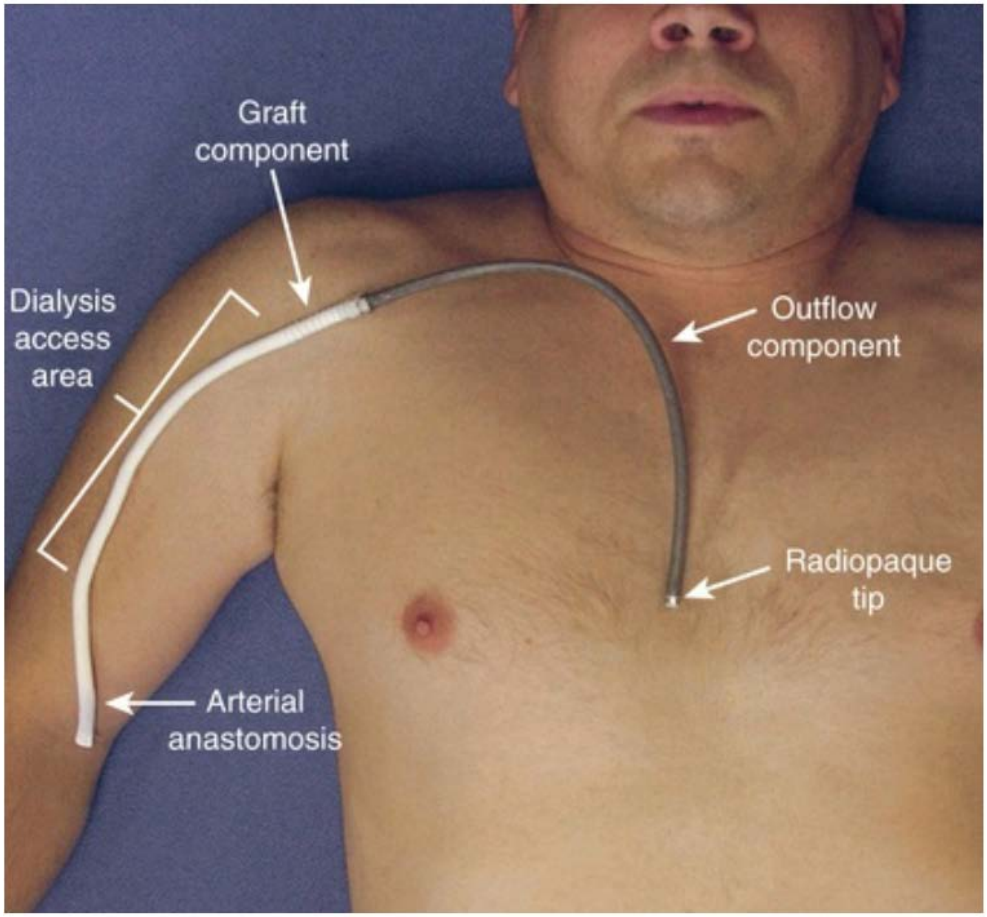


Fig 7: Placement of a device for hemodialysis reliable outflow (HeRO) vascular access [33]

Chapter 3

"Hemodynamics and patho-physiology"

Arterio-venous fistula is the union of a vein and an artery in such a way as to allow blood flow from the artery into the vein back to the central venous circulation. (34)

Blood flow:

Blood flow in the proximal artery is always increased depending to a large extent on the diameter and the length of the fistula and to a lesser extent on the resistance of venous outflow, the collateral arteries and the peripheral vascular bed. Blood flow in the proximal vein is not only greatly increased but also becomes more pulsatile, with peak flow rates coinciding with the arterial systole. Because of the compliance of the vein wall, the pulsations are prominent only when the proximal vein is stenotic or occluded. Flow in the distal artery has three possibilities: A: Flow in the normal peripheral direction occurs when the fistula is small with high resistance and poorly developed arterial collaterals. B: Flow in a retrograde direction occurs in large, chronic, low resistance fistulae when the arterial collaterals are well developed. C: Stagnant flow occurs when the fistula is large and acute before the collateral arteries are well developed. In this case blood may flow in the normal peripheral direction during systole but reverse during diastole. (35)

The size of the vein and the artery used in AV fistulae has a dramatic effect on the flow in the fistula. Blood flow is minimal until the diameter of the vein exceeds that of the donor artery by 20 %. If the diameter of the vein exceeds that of the artery by more than 75%, the blood flow increases dramatically but remains primarily limited by the venous resistance. Blood flow in a radial artery-based

fistula commonly ranges between 150 and 400 ml/min. The larger brachial and femoral arteries may allow flow as high as 500 to 1500 ml/min. The bruit and thrill so characteristic of an arterio-venous fistula are the result of turbulent flow patterns that cause vibrations in the wall of the associated blood vessels. [35]

Anatomic changes:

Because of the increased arterial and venous blood flow, morphologic changes occur in the contributing vessels of the fistula. In general, the opening between the artery and the vein increases with time; but few fistulae close spontaneously or become smaller. One of the most characteristics is the progressive distention and elongation of the proximal artery which may become very tortuous and aneurysmal. Although the artery is initially thickened, it eventually undergoes degenerative changes with atrophy of smooth muscles, decrease of the quantity of the elastic tissue and the formation of atheromatous plaques. These changes are irreversible especially if the fistula lasts for more than two years. Similar changes are observed in the proximal vein which becomes also dilated and tortuous. The wall becomes irregular and thick due to intimal proliferation and fibrosis. The internal elastic lamina tends to fragment and disappear. For these reasons the term (arterialization) often is used to describe the changes in the venous wall. Maturation of an AV fistula involves dilatation of the run-off vein, thickning of its wall, and enlargement of the afferent artery. It usually takes 4-8 weeks after establishment of the fistula. [16].

Blood pressure:

Blood pressure in the proximal artery is usually well maintained. Both systolic and diastolic pressures may be somewhat depressed in the acute large fistula while in chronic fistula, the proximal artery becomes dilated and the pressure may exceed those in comparable normal arteries at the same anatomical level. The pressure in the distal artery is always reduced while in the proximal vein

usually remains quite low despite the additional influx of blood from the fistula owing to low outflow resistance of the proximal vein and remarkable compliance of the venous wall. [35]

Systemic effect:

Opening an arterio-venous fistula produces an immediate reduction in total peripheral resistance. This is the essential patho-physiological change responsible for all the systemic effects of the arterio-venous fistula. This causes blood to be transferred from the arterial side to the venous side of the circulation, the central arterial pressure drop, the central venous pressure rise and the systemic blood flow decrease. A number of compensatory mechanisms are called into play to correct these physiological aberrations: increasing stroke volume and heart rate, systemic arteriolar constriction, which helps to maintain central arterial pressure and constriction of the central veins which facilitates venous return. [35]

If compensation is adequate as it usually is in most patients with good cardiac function, the cardiac output will increase sufficiently to permit central aortic pressure to approach the pre-fistula values. Baro-receptors effects are thereby decreased, allowing the pulse rate to return to normal levels and the peripheral vascular constriction to be alleviated. The reduction of heart rate with occlusion of AV fistula is referred to as Nicoladoni – Branham´S sign. If the fistula is massive or the myocardium is damaged, compensation will be incomplete. Cardiac output, although increased, will be insufficient to maintain peripheral blood flow in the face of the great leak between the two sides of the circulation. Cardiac failure will be ensuing and early death may result. [16]

Chapter 4

Advantages of arterio-venous fistula

Fistulae, over all other forms of access, have the lowest costs of implantation and access maintenance [(36)] and offer a lower rate of complications: Fistulae have the lowest rate of thrombosis and require the fewest interventions, so providing longer access survival [(37)].Fistulae have lower rates of infection than grafts, which, in turn, are less prone to infection than percutaneous catheters and subcutaneous port catheter systems**.** Vascular access infections in HD patients are common, can be severe, and contribute as the second leading cause of death in patients with end stage renal disease [(35)]**.** Patients receiving catheters and grafts have a greater mortality risk than patients dialyzed with fistulae. Epidemiological evidence indicates that greater use of fistulae reduces mortality and morbidity. [(38)]

Autogenous Arterio Venous Fistula (AVF)

Autogenous arteriovenous fistulas (AVF) are the preferred mode of vascular access for maintenance hemodialysis (HD) in patients with end-stage renal disease (ESRD) because of their good long-term patency and low complication rate. [(34)]

The primary use of autologous AVF is recommended by the National Kidney Foundation-Dialysis Outcomes Quality Initiative(NKF-DOQI) practice guidelines which include the following: The access should provide sufficient blood flow to perform adequate hemodialysis, Autogenous AVF should be preferred over arteriovenous graft (AVG) and AVG should be preferred over catheters, Upper extremity AVF should be the preferred access and should be placed as distally as possible, Fistula maturation should be monitored to allow early intervention if needed. [(39)]

Prerequisites for adequate dialysis angioaccess include that it has to be able to provide a minimum of 400 mL per minute of blood to flow through the dialysis

machine and has to accept a similar volume for return as lower flows make dialysis inefficient. Also, it has to be easily cannulated. The vein has to be superficial, so that needle cannulation can be done safely and easily. In the case of urgent hemodialysis, it must allow immediate use after implantation.In the case of chronic hemodialysis, it has to allow for repetitive cannulation (i.e., three times per week), and have long-term patency and low rate of complications. [34]

There are different options for AVF constructions in the upper and lower extremities. The autogenous veins that can be used for AVF construction in the upper extremity are cephalic, basilic, antecubital, brachial veins, translocated great saphenous vein and translocated superficial femoral vein while the autogenous veins that can be used for AVF construction in the lower extremity are saphenous and superficial femoral vein. [40]

Brachial veins:

Bazan et al. reported the use of the brachial vein for creation of AVF in 2004 as a new technique for patients with no usable superficial veins in the upper limb [41]. Dorobantu et al. reported their mid-term results in 49 patients in whom brachiobrachial AVF was constructed in two stages. One month after surgery, 40 (81.6%) of these patients had a functional fistula, but in only 39 (79.6%) cases was the fistula suitable for HD following transposition to the subcutaneous tissue. Seventeen patients developed temporary edema of the forearm during the first month, in three cases the edema extended to the entire arm, but no other complications were associated with the procedure. [42]

Brachial vein is situated quite deep in the upper arm. Moreover, because of its limited available length, it is recommended that the formation of brachiobrachial AVF and its transposition should be undertaken only by surgeons with a good amount of experience in vascular access surgery. [42]

Translocated GSV to the upper extremity:

Use of saphenous vein translocation to the upper limb(autograft) for creation of AVF is theoretically an attractive option. It can be used as loop or straight configuration. [43]

In the 1970, saphenous vein was translocated to the upper extremity as a forearm loop in patients with exhausted or unsuitable upper limb superficial veins by Girardet R. et al., who preferred forearm saphenous loop over thigh saphenous loop due to higher infection rate in the groin region and potential vascular complication associated with access in the lower extremity. [44]

Unfortunately, the problem of intimal hyperplasia and stenosis related to the venous anastomosis was not known at the time –a problem which is avoided by performing the procedure in the thigh. The thigh location appears to be favored currently when using the saphenous vein except for the patient with diabetic or other arterial occlusive diseases in the lower extremities. [45]

Ischemic and infection complication rates are respectively reported as being related to the high flow access and groin incision and ongoing cannulations nearby. Finally, the overall higher patency rates associated with the upper extremity versus the thigh location may be explained by the higher pressures and flows (and turbulence) in lower extremity AVFs and in loop configurations, factors inducing more rapidly progressive stenosis. [46]

There are no many studies reporting the results of saphenous vein translocation to the upper arm as a graft between brachial artery and axillary vein. Being an autogenous graft, its results are expected to be better than prosthetic grafts, but, in the absence of any published evidence, it is difficult to make a recommendation. [46]

Synthetic AVF (ArterioVenous Graft)

The extent of use of prosthetic material for creation of AVF has varied significantly from one part of the world to the other. Whereas most parts of Europe have used grafts only to a limited extent, in theUnited States, there has been a fairly high usage of grafts in AVF construction. [47]

Vascular access grafts (VAG) provide an access in most patients whose superficial vein network does not permit the creation of a good native AVF or previously exhausted. Regardless, synthetic grafts have generally exhibited lower survival rates and higher complication rates than native AVF [48]. Graft patency is also limited by continuous vein punctures, which deteriorate synthetic materials and may alter internal VA hemodynamics.. For these reasons, continuous effort is made to obtain materials that can improve patency and decrease complications and failure rates. [49]

Currently, a number of alternative graft materials are commercially available: Poly-tetra-fluoro-ethylene (PTFE) been modified in many ways by changing pore size [50], wall thickness and by adding rings, outer wraps, venous cuffs, and coating to the luminal surface [51]. Tapered and stretch grafts are also available, and new tunneling sheaths have been developed to reduce complications of graft insertion [52]. A new kind of multilayered, self-sealing polyurethane is also available. This material provides a suitable VA immediately after implantation and offers the additional advantage of a short time to hemostasis [53]. Bio prostheses derived from bovine mesenteric vein, such as ProCol area valid alternative to PTFE in patients at risk of thrombotic events [54]. They have been reported to show the longest patency rate compared with other grafts, even in patients with multiple failed accesses, but they are no longer commercially available [55].

Cryopreserved human femoral vein grafts have been introduced into surgical practice. They are “immune invisible,” and therefore not thrombogenic,

thanks to the elimination of the native cellular wall component by antigen-reduction technology and the endothelialization of the luminal surface by the recipient's cells. However, this kind of graft is not indicated in the general dialysis population but only in selected cases [(56)]. The Omniflow Vascular Prosthesis II (OVPII; Bio Nova International Pty Ltd, North Melbourne, VIC, Australia) is a collagen-polyester composite that has been successfully used for peripheral vascular replacement and as an arteriovenous bridging graft for hemodialysis [(57)]. It is a truly integrated biosynthetic composite of polyester mesh and bovine connective tissue components. OVPII is composed of a polyester net set on a silicon mandrel that is implanted on the sheep's back to form a tube of collagen that is fixed by glutaraldehyde at the moment of removal. This prosthesis has the advantage of the natural collagen, deprived of its immunogenicity, and the polyester net provides increased mechanical resistance to deterioration after repeated puncturing.It combines the excellent biocompatibility and hemocompatibility of the biologic collagenous tissue with the strength and durability of the integrated polyester mesh. [(58)]

The advantages of OVPII make a difference in demanding applications such as hemodialysis access. In fact, the tissue wall is easily punctured, even for home dialysis patients, and OVPII allows high-flow dialysis rates to be easily achieved. The self-sealing properties ensure that hemostasis is rapidly obtained after the dialysis session with minimum pressure, which reduces the risk of thrombosis. [(55)]

Many clinical studies have demonstrated that OVPII has excellent long-term performance, with a recorded patency of 10 years, superior to other commonly used prostheses and not significantly below that of autologous fistulas. Furthermore, OVPII demonstrates excellent resistance to infection in AV access situations. [(59)]

The basic technique for use of grafts in creation of AVF involves two incisions, one for exposure of the feeding artery and the other for proposed venous outflow. The graft is then tunneled subcutaneously from one incision to the other and both ends are anastomosed end-to-side to the planned vessels. Prosthetic grafts have inferior primary and secondary patency rates and higher incidence of some complications such as infections and thrombosis compared with autogenous fistulae**.** As a result, the last decade has seen a gradual and intentional shift toward increasing the use of autogenous AVF. **(60)**

Prosthetic grafts can be used in the upper limb for construction of AVF in three basic configurations**.** The forearm grafts are used either in straight or loop configurations. In the straight variety, the distal radial artery provides inflow and venous outflow is through the antecubital vein. Loop graft is performed between brachial artery and antecubital vein. **(40)**

The upper arm grafts are placed between the brachial artery in antecubital fossa and the axillary or brachial vein in axilla. Keuter et al. compared brachiobasilic autogenous AVF with prosthetic forearm loop in a prospective randomized trial. Primary and assisted-primary 1-year patency rates were significantly higher in the autogenous brachiobasilic group. The rate of complications was 1.6 per patient-year in the brachiobasilic group vs. 2.7 per patient-year in the Poly-tetra-fluoro-ethylene (PTFE) group **(61)** . Other investigators have also confirmed the superiority of upper arm autogenous fistulae over forearm grafts. **(62)**

Thus, in the presence of healthy upper arm veins, which are a prerequisite for placement of forearm grafts, placing upper arm autogenous fistulae should be preferred over forearm loop grafts. Many studies have compared upper arm autogenous fistulas with upper arm grafts. **(60)**

Lazarides et al., conducted a meta-analysis comparing brachiobasilic AVFs with upper arm grafts. They recommended use of brachiobasilic autogenous AVF prior to grafts based on their superior outcomes and lower complication rates. **(63).**

Chapter 5

Preoperative Evaluation of the patient for Hemodialysis

Fistula Placement:

Preoperative assessment of the patient referred for permanent dialysis access may be the most important factor in providing a properly functioning arteriovenous fistula. The rate of loss of renal function in patients with chronic renal failure is usually predictable. Patients with creatinine clearance values of 10 mL/min or less are almost certain to need dialysis within 3 months. Permanent vascular access should be established early in patients selected for hemodialysis, since maturation time is needed before the system is usable, particularly if an autologous fistula is constructed. [(64)]

Diagnostic evaluation prior to permanent access selection:

History : it includes history of central venous catheter placement to exclude the possibility of central venous thrombosis or stenosis, the dominant arm: to minimize the negative impact on the quality of life, the use of the non-dominant arm is preferred, history of severe congestive heart failure may alter the hemodynamic and cardiac output, history of arterial or venous peripheral catheter as this may damage target vasculature, history of anticoagulant therapy or any coagulation disorders, presence of co-morbid conditions that may limit patient life expectancy; as morbidity associated with placement and maintenance of vascular access may not justify their use in some patients, history of vascular access; as previously failed vascular access will limit available sites and causes of previous failure may influence the plan, anticipated kidney transplantation: as catheter access may be sufficient, history of modified radical mastectomy should defer the ipsilateral limb from being used as a site for AV access. [(65)]

Physical Examination: **Physical examination of the arterial system:** includes assessment of character of peripheral pulse, as an adequate arterial system is needed for the access and the quality of arterial system will influence the choice of the access site. Bilateral arm blood pressures which determine suitability of A-V access. **Physical examination of the venous system:** includes evaluation of edema and differential arm size which indicate venous outflow problems that may limit potential access sites, examinations of collateral veins as collateral veins are indicative of venous obstruction, examination for previous central or peripheral venous catheterization that may lead to central venous stenosis or may damage target venous vasculature. **Cardiovascular evaluation:** Evidence of heart failure may alter cardiac output affecting success of access construction. [65]

Duplex scanning:

Vascular mapping in preparation for the creation of a vascular access refers to evaluation of both arterial and venous systems:

The arterial evaluation should include pulse examination, differential blood pressure measurement, assessment of the arterial diameter, the palmer arch for patency, and the presence of arterial calcification. Presence of main arterial stenosis proximal or distal to the planned site for AVF may lead to failure of the access or steal respectively. A preoperative arterial diameter less than 1.6 mm has been associated with a high failure rate in radio-cephalic fistulae **(61).** Previous studies suggested that a minimum diameter of 2.0 mm is required for successful fistula creation. [64]

Venous evaluation should include a luminal diameter of 2.5 mm or greater, continuity with the proximal central veins, and absence of obstruction. Several studies support the 2.0 to 2.5 mm vein diameter as a threshold for successful creation of a fistula. Radio-cephalic fistulae constructed in veins less than 2.0 mm

in diameter had only 16% primary patency at 3 months compared with 76% for those with veins greater than 2.0 mm. [66]

Central veins should be evaluated in the appropriate patient known to have a previous catheter or pacemaker. The central veins may be assessed indirectly by using duplex ultrasound which had a specificity of 97% and sensitivity of 81% for detecting central vein occlusion. Alternatively, magnetic resonance angiography (MRA) may be used to evaluate the central veins. [67]

Surratt et al. (1995) performed upper extremity venography in 43 patients (62 extremities) prior to placement of a permanent vascular access graft. A 40% incidence of significant subclavian vein stenosis or occlusion was found in patients with prior or existing temporary dialysis catheters in the subclavian vein. No stenosis was found in patients without a history of dialysis catheters in the subclavian vein. The authors concluded that the subclavian vein should be evaluated preoperatively in any patient with a history of subclavian vein catheterization. Furthermore, they encouraged the use of sites other than the subclavian vein for temporary hemodialysis access.[68]

Venography prior to placement of access is indicated in patients with the following: (a) edema in the extremity in which an access site is planned; (b) collateral vein development in any planned access site; (c) current or previous subclavian catheter placement of any type in venous drainage of planned access; (d) current or previous transvenous pacemaker in venous drainage of planned access; (e) previous arm, neck, or chest trauma or surgery in venous drainage of planned access; (f) multiple previous accesses in an extremity planned as an access site. Additional or alternate imaging techniques are indicated in selected cases where multiple previous vascular accesses have been placed or when residual renal function makes contrast studies undesirable. Appropriate techniques include (a) Doppler ultrasound (evidence) and (b) magnetic resonance imaging. [69]

Arteriography or Doppler examination is indicated when arterial pulses in the desired access location are markedly diminished. The ‘‘gold standard’’ for evaluation of central venous stenosis remains contrast venography. Duplex screening has been performed, but may miss lesions particularly in the portion of the vein behind the clavicle. [(69)]

Knudson et al. (1990) evaluated 91 patients with suspected upper extremity venous thrombosis and found the sensitivity of venous duplex was 78% with a specificity of 92%. They noted four cases of isolated superior vena cava or proximal innominate vein obstruction that were missed by color Doppler imaging. [(70)]

Selection of Permanent Vascular Access and Order of Preference for placement of AV Fistulae:

Due to easier accessibility and lower infection rates, upper extremity access sites are used first, with the nondominant arm given preference over the dominant arm. AV accesses are placed as far distally in the extremity as possible to preserve proximal sites for future accesses. As long as the patient is deemed appropriate, given their superior patency rates and lower complication rates, autogenous AV accesses should always be attempted before a prosthetic AV access. These autogenous access configurations should include, in order of preference, direct AV anastomosis, venous transpositions, and venous translocations (as GSV translaocation). [(16)]

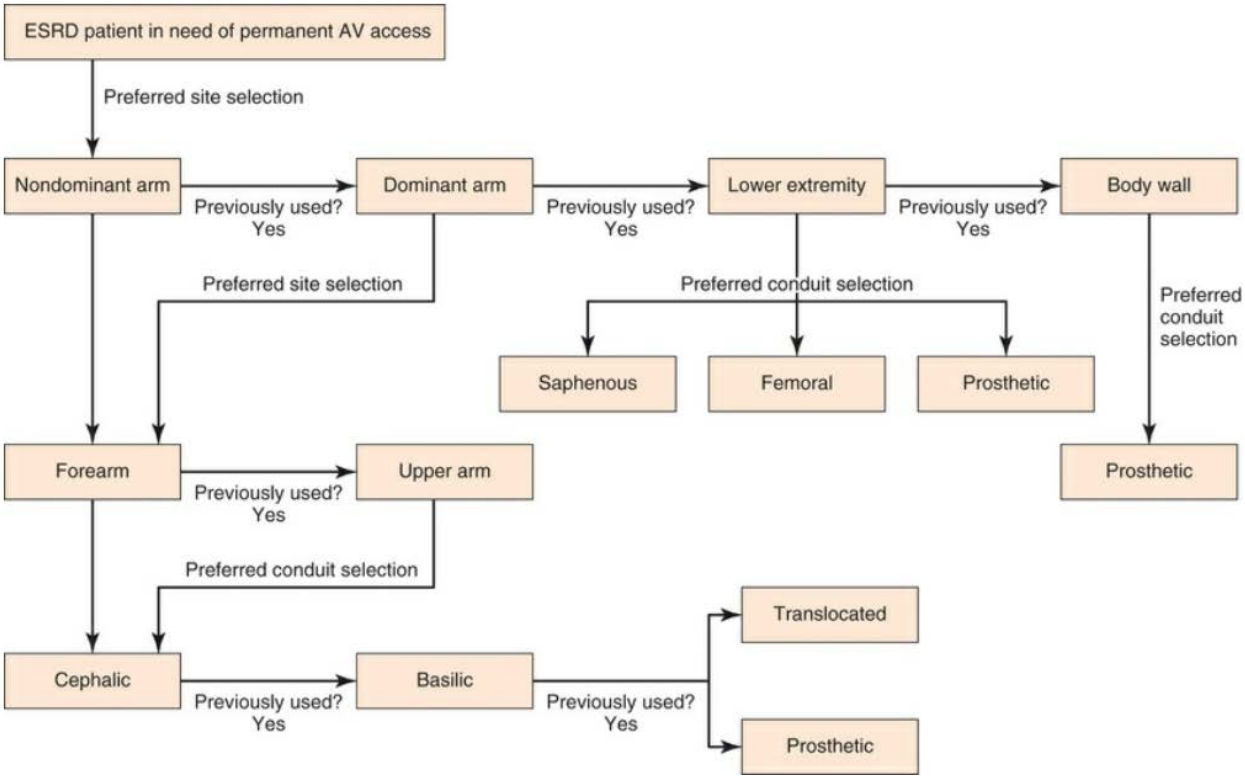


Fig (8) : Algorithm: selection of access location. [16]

Saphenous Vein Transposition

The common femoral artery–saphenous vein loop transposition was first described in a single patient by May et al. in 1969. Based on the limited number of series17–19 reporting the outcome of saphenous vein translocation, the following conclusions can be drawn: (1) The use of skip incisions or endoscopic techniques to harvest the saphenous vein may decrease the wound complications associated with this procedure; (2) because the great saphenous vein does not readily dilate after access creation, only veins greater than 3 mm in diameter should be used and the vein must be tunneled just beneath the dermis to allow reliable cannulation of the access; (3) cannulation of the access must be delayed at least 6 weeks postoperatively to prevent puncture-site bleeding and hematoma; (4) the procedure may not be practical for patients who are morbidly obese or those

with a large redundant pannus because access cannulation may require the patient to lie in the supine position and retract the pannus to expose the access. [16]

Prosthetic AV Grafts:

The expanded polytetrafluoroethylene (PTFE) graft was first used as a bridge conduit in 1976 and is currently the most popular method of establishing longterm dialysis access. Criteria for placement of PTFE grafts are failure of autogenous fistula, lack of adequate superficial veins for an autogenous fistula, or deeply embedded veins, as are usually found in obese patients. The most common reason for lack of superficial veins is multiple prior intravenous cannulations. [71]

General principles of access surgery:

Several guiding principles should be followed

It is preferable to use the arm vessels for access rather than the leg vessels as infection and arterial occlusion are less common in the upper extremities. Inadequate or atherosclerotic arteries should be avoided, and a long section of patent runoff vein is required to accommodate multiple cannulation sites. The chosen site should allow for ease of access for cannulation and should be positioned so patient comfort is ensured during hemodialysis. Placement of a forearm arteriovenous bridge graft in the operating room is safer than the insertion of a percutaneous central venous dialysis catheter. Technical precision and gentle tissue handling are mandatory: the use of optical magnification, fine monofilament suture materials, atraumatic clamps, and microvascular instruments is recommended. An arteriovenous anastomosis is unlikely to provide satisfactory flow for hemodialysis if the vein is less than 2.5 mm in diameter. A temporary access procedure; such, as placement of a double-lumen venous catheter (usually in the internal jugular, subclavian, or femoral veins), external shunt or peritoneal catheter, may be required during the time that the permanent access vessels are ma-

turing before use. Anticoagulation is not necessary during routine access operations, except for graft thrombectomy and revision procedures or for patients who do not have the usual hypocoagulable state of chronic renal failure. Prophylactic antibiotics are used for all cases that involve the insertion of prosthetic material. Infection is a major cause of morbidity and the second leading cause of death in patients undergoing hemodialysis. [72]

Chapter 6

POSTOPERATIVE SURVEILLANCE OF DIALYSIS ACCESS

Patency Assessment:

Valid comparisons on patency can be made only if patency is defined in a way that can be universally used by all specialties in a consistent manner. **Primary patency**: This is the interval from the time of access placement until any intervention designed to maintain or reestablish patency, access thrombosis, or the time of measurement of patency .**Secondary patency**: This is the interval from the time of access placement until access abandonment, thrombosis, or the time of patency measurement including intervening manipulations (surgical or endovascular interventions) designed to reestablish functionality in thrombosed access. [(73)]

Fistula lifespan improved when a protocol of surveillance is initiated and prophylactic intervention is undertaken to correct high-grade stenosis **.**Any useful method of access surveillance should be sensitive in the detection of venous outflow stenosis, since it is the most common cause of access failure. The problem of distal anastomotic myointimal hyperplasia is well recognized. It is estimated that 60 to 90% of access fistulae fail because of venous outflow stenosis, Surveillance methods should also be able to detect more proximal venous outflow problems, given the significant incidence of subclavian vein stenosis due to the previous placement of a line for subclavian dialysis access. [(74)]

Clinical Indications of Impending Dialysis Access Failure:

There are several important clinical indications of impending fistula failure. These signs are often noted by attentive personnel in the dialysis facility and should not be ignored. Prolonged bleeding after needle removal is a subtle sign of venous outflow obstruction either at the venous anastomosis or in the proximal

subclavian vein. Significant arm edema, occasionally with noted development of prominent chest wall venous collaterals, is also an important clinical sign of central vein stenosis or occlusion. This problem should be pursued aggressively with fistulography and venography. Good results with salvage of failing fistulae have been reported with balloon angioplasty and stent placement for proximal subclavian vein stenosis. [75]

Routine palpation of the fistula or access can also provide useful clinical information, if palpation of the fistula reveals that flow has become pulsatile, this is a strong clinical sign of venous outflow obstruction. In addition, the character of the thrill is important. With a low-flow fistula, either due to venous outflow problems or an arterial inflow stenosis, the thrill is often decreased. Moreover, as venous outflow stenosis progresses, the thrill over the venous anastomosis will often increase in severity and be associated with a harsh bruit. Such physical findings should lead to further evaluation of the access, as outlined below. [75]

Monitoring Primary AV Fistulae for Stenosis: includes 1. Primary AV fistulae should be regular clinical examination.2. Direct flow measurements, if available, are preferable to more indirect measures.3. Methods appropriate for monitoring stenosis in grafts (e.g., venous pressures) are not as accurate for monitoring in primary AV fistulae. Recirculation and Doppler analysis are of potential benefit. [76]

Access Surveillance Techniques:

Methods of AV access surveillance fall into two broad categories.

The first includes measurements performed at the time of hemodialysis. Such measurements should be obtained and recorded on a regular basis to establish baseline values for each individual's access site and to detect serial changes in access function. These measurements include intragraft pressure,venous pressure measurement ,recirculation time and efficiency of dialysis.The second broad

category of surveillance techniques involves the application of Doppler technology based duplex scanning. [76]

1- Intragraft pressure:

In addition to the clinical findings noted above, several fairly simple measurements can be made at the time of hemodialysis access, which may result in the identification of impending access failure. In patients with AV grafts, a pressure greater than 50 mmHg recorded in the venous needle prior to initiating blood flow suggests venous outflow stenosis. When such a stenosis is suspected, complete duplex scanning of the access should be performed to identify the site of the stenosis. If no stenosis is evident in the graft or the venous outflow site, fistulography should be performed to include views of the proximal subclavian vein, as this might be the site of stenosis and a cause of increased intragraft pressure. [77]

2- Venous pressure:

Measurement of venous pressures during dialysis has been shown to be an accurate method for the identification of impending fistula failure. It is important to note that the venous pressure measurement is blood flow-dependent. In many modern dialysis access facilities, blood flow rates exceeding 400 mL/min are now used in order to increase the efficiency of dialysis and decrease the time required for the dialysis session. Measurement of venous pressures at such high flow rates has not proven to be accurate. However, the measurement of venous pressures exceeding 150 mmHg at blood flow rates of 200 to 225 mL/min is associated with a failing fistula and usually a greater than 50% stenosis within the fistula itself [78]. With the use of a 16-gaugc needle, the venous pressure will usually average approximately 75±30 mmHg. A venous pressure measured in this fashion during the first portion of dialysis greater than 145 to 150 mmHg is abnormal and suggests a greater than 50% stenosis in the fistula. When blood flow rates are

increased to 300 mL/min, a venous pressure of greater than 170 mmHg is considered abnormal. [74]

3- Urea recirculation:

Calculation of urea recirculation has also been useful for detecting impending fistula failure. It can be readily performed in the dialysis center and is usually done monthly during the first hour of hemodialysis. The suggested method involves a two-needle technique in which blood urea nitrogen (BUN) samples are drawn from both the arterial and the venous lines. It is important to note that as blood flow rates are increased, the urea circulation also increases. For this reason, determination of urea recirculation is less accurate at higher blood flow rates. Data suggest that if the urea recirculation is greater than 10%, there is a 79% likelihood of detecting a venous stenosis by fistulography. It is also important to note that urea recirculation is dependent on the location of the fistula with higher-flow proximal fistulae and loop fistulae having greater baseline urea recirculation values than distally placed or low-flow fistulae. Measurement of urea recirculation can also be evaluated following fistula revision. If the fistula revision is successful,the urea recirculation should return to normal (less than 10%). Urea recirculation calculations are not expensive and newer dialysis machines are incorporating the technology to provide continuous biochemical feedback during the dialysis session. [79]

4- Effeciency of dialysis:

The advent of hemodialysis therapy has converted end stage renal disease from a terminal illness to a chronic disease state. Similar to the management of many other chronic diseases, it is essential to monitor adequacy of treatment to ensure the well being of patients. To monitor adequacy of dialysis, blood investigations are done at least once a month. While the presence of persistent

hyperkalemia, or metabolic acidosis is suggestive for insufficient clearance, urea has always been used as the conventional marker for dialysis clearance. [79]

5-Duplex Ultrasound Detection of AV Fistula Stenosis:

Serial surveillance of AV fistulae is performed and prophylactic intervention carried out when significant anatomic lesions are identified. Duplex ultrasound detection of AV fistula stenosis is a theoretically attractive technique. The studies are noninvasive, can be repeated serially, and are accurate in the localization of fistula stenoses. [80]

The simplest technique is examination of the inflow arterial waveform. It is important to remember that the diastolic component of an arterial waveform reflects the resistance of the vascular bed being perfused. For example, normal peripheral arterial waveforms exhibit no forward flow in diastole or even reversal of flow in diastole because of the elastic recoil of high-resistance peripheral arteries. Normal peripheral arterial waveforms are thus triphasic. In contrast, in circulatory beds with low resistance, there will be significant forward flow in diastole. So monitoring arteriovenous fistulae is by examining the native arterial waveform proximal to the fistula. For example, the brachial artery examined proximal to the arterial anastomosis. A normally functioning AV fistula has significant diastolic flow and the ratio of the Doppler derived velocity in peak diastole divided by the velocity in peak systole makes it possible to determine a flow ratio (Vd/Vs). A normally functioning fistula without significant outflow problems has a Vd/Vs ratio >0.4. With significant stenosis in the fistula or outflow tract, the diastolic flow component decreases, resulting in a Vd/Vs ratio <0.3. [80]

To perform duplex surveillance, the entire fistula or graft should be examined, including the inflow artery, the proximal anastomosis, the graft/fistula itself, the distal anastomosis, and the outflow vein. The peak systolic frequencies or velocities are then recorded and ratios determined by comparing the frequency

at the site of the stenosis with the baseline frequency in the inflow artery proximal to the anastomosis. Color-flow Doppler can assist in identifying anatomic areas of stenosis for further interrogation with velocity or frequency measurements. Once velocity data are obtained, volume flow can be determined in areas of uniform diameter by using calculations incorporated in most imaging systems. [81]

Fistulae care

If the fistula is created with adequate inflow artery and outflow vein, the increased flow in the vein should be immediately apparent postoperatively, evidenced by the presence of a continuous palpable and audible thrill along the vein**.** All newly created fistulae must be physically examined by using a thorough systematic approach 3 to 6 weeks postoperatively to ensure appropriate maturation for cannulation**.** Poor prognostic signs, such as significant decrease in the thrill at any time, should be referred immediately back to the surgeon for prompt evaluation and intervention. [82]

Fistula examination:

A- **Inspection:**

In normal fistula there is well developed main venous outflow, no irregular areas or aneurysm formation and there are areas of straight veins that can be used for cannulation. In poorly matured fistula, there are multiple venous outflow veins (accessory veins) and poorly defined cannulation sites In stenosed fistula we look for a narrowing of the outflow vein, aneurysm formation, dilated neck veins or small surface collateral veins in the arm or neck above the vascular access. Infected fistula looks red swollen, indurated and the skin looks broken, while in steal syndrome, the hand of the access looks discolored due to poor arterial flow. [65]

B- Palpation:

In normal fistula a thrill is felt at the arterial anastomosis and throughout the entire outflow vein that is easy to compress. Infected fistula is felt warm and

swollen. Compare temperature, grip strength, range of motion and any tenderness. If the access limb has any major temperature difference than the non-access limb, steal syndrome is considered. [65]

C: Auscultation:

Low pitch continuous systolic and diastolic sound is listened with stethoscope in normal fistula while in stenosed fistula; high pitch discontinuous systolic sound is listened. In steal syndrome, the fistula may have very strong bruit [35]

Initial cannulation of the mature fistula:

The fistula is considered mature when the diameter of the vein is greater than o.4cm, has a flow greater than 400 ml/min and at least 1 month has elapsed since fistula creation . It is best to perform the initial cannulation of the new access at the patient's midweek HD treatment to avoid such complications as fluid overload and elevated chemistry results associated with the weekends. [35]

Choice of cannulation sites:

The choice of cannulation site is extremely important in the long-term maintenance of an internal vascular access. Repeated use of the same easy dilated areas or patient preference for specific sites can result in aneurysms and other equally serious complication. The following are some guidelines in the choice of a site.Know the anatomy of the fistula or graft. A progress note with a picture of the access by the vascular surgeon is very beneficial to dialysis personnel.Determine direction of the flow. If the direction is unknown, occlude the vessel with a finger and check both sides of the occlusion the arterial side will pulsate.Check for signs of infection or hematoma. Report infections immediately, and do not puncture the infected area.Rotate cannulation sites, keeping at least 1 inch away from the previous site to allow for adequate healing. Evaluate the entire usable area when choosing sites.Place the arterial needle near the anastomosis for greatest blood

flow. To lessen damage to the intima and to decrease the risk of thrombosis, the tip should not however, be closer than 2 cm to the anastomosis site. Placement of the needle toward or away from the anastomosis is dependent on the ability to achieve optimal blood flow.Place the venous needle proximally or upstream, 8 to 10 cm from the distally placed arterial needle, to avoid the mixing of arterial and venous blood.Rotate the extremities if the patient has more than one access. [83]

Instructions to patients with vascular access : To avoid occluding the blood flow to the extremity and the fistula, the patient is instructed to avoid carrying heavy objects, wearing clothes with tight or elastic bands, hanging the arm over the back of a chair, leaving the blood pressure cuff on the extremity for long periods of time and sleeping on the arm.Check blood flow several times each day by feeling the strength of thrill. Avoid extremes of heat and cold.Don't measure blood pressure or have blood drawn from the arm with vascular access.Report any pain, redness or swelling immediately. Swimming, showering and bathing is permitted after puncture site have healed. [83]

AFTERCARE:

AV fistulas and grafts require minimal aftercare. As the fistula needles are removed, pressure is applied to the puncture site with a sterile 4x4-or 2 x 2-inch gauze dressing. Bleeding usually subsides within 15 minutes. Fistula puncture sites clot faster than do graft puncture sites. Adhesive bandages or a dressing, depending on patient preference, unit protocol, or length of bleeding, is applied. If a dressing with tape is used, the tape should not be applied so tight as to obstruct blood flow. The patient should be instructed to remove the dressings in 4 to 6 hours. If bleeding from the puncture sites occurs later, the patient should be instructed to apply pressure over the area until the bleeding subsides. The life of the AV fistula or graft can be prolonged with careful cannulation techniques. Capable patients should be taught to self-cannulate their fistulas, because this has been shown to prolong graft surviv

Chapter 7

Complications of Arteriovenous Fistula

Autogenous arterio venous fistulas are the preferred vascular access for patients with end-stage kidney disease. They are cheap and easy to construct, have excellent patency rates and require minimal maintenance by the patient and the health care staff. However, they can develop various complications, which have different rates of incidence, morbidity and mortality. Most of them threaten the function of the fistula and some of them even pose an immediate vital risk. It is important that all health care professionals who deal with patients on whom an AVF is performed should have thorough knowledge of the types, physiopathology, risk and treatment of such complications. The patients with ESRD have numerous comorbidities besides the end-stage kidney disease; among them, diabetes mellitus, hypertension and chronic viral hepatitis which augment the complication rate after any surgical intervention. The complications of AVF can be divided into acute and chronic complications. [84]

Acute complications:

These are complications that occur in the first hours or days after the construction of an AVF and always require evaluation by a vascular surgeon as :

Thrombosis:

Thrombosis of the fistula occurs when there is inadequate flow through the fistula, which leads to stasis and thrombosis. Thrombosis of the fistula occurs mostly in patients with inadequate venous run-off, i.e. history of subclavian vein catheters, multiple venous punctures with local fibrosis. [85]

Preoperative Duplex examination was not used to assess the vein. Local inspection at the time of surgery should be performed, and if the vein is small, fibrotic or with a visible thrombus inside, another vein should be used. The vein

can be assessed by flushing it with a heparinized saline solution via a catheter; if there is resistance in advancing the catheter, injecting the solution or no backflow through the catheter, a proximal stenosis of the vein should be suspected, which leaves no alternative but using a different vein. Building an anastomosis that is too tight, restricting the blood flow, coupled with systemic hypotension can also be incriminated in acute thrombosis. [85]

The blood pressures of the patients should be maintained in the 130-150 mmHg intervals during the fistula's maturation period. Hypotension sometimes occurs during the hemodialysis (HD) session performed after the operation, using an indwelling HD catheter. This is the reason why a newly constructed fistula should be assessed by the medical staff at the beginning and end of all HD sessions).Introducing a catheter on the subclavian vein of an arm with a functional AVF can lead to thrombosis, either immediate or after the first HD session. Other causes of thrombosis are extrinsic compression of the operated arm, e.g. wearing clothes with tight sleeves or sleeping on the respective arm. [42]

In the acute setting (during the first 12-24 hours), thrombosis can be solved by surgical thrombectomy. If, on palpation, the vein is tender, pulsatile in the initial segment but with no thrill, the vein can be opened longitudinally and a Fogarty catheter passed both distally (towards the subclavian vein) and proximally (towards the anastomosis). Flushing the vein with a heparinized saline solution is mandatory. A thrill should be obtained after removing the cross clamp. There is an increased risk of pulmonary embolism associated with this procedure, making its use subject to a very careful evaluation of the patient and close monitoring. [84].

Bleeding:

Bleeding is the most common acute complication. Spontaneous bleedings are not uncommon in uremic patients, in whom the primary mechanisms of hemostasis are compromised, including thrombocytopenia, platelet dysfunction and von Willebrand factor's changes. Chronic anemia, which is common in uremic patients, also negatively influences the rheologic component of the platelet – vascular wall interaction. All of these factors concur to the fact that, in the postoperative setting, a bleeding is unlikely to spontaneously. [(84)]

The wound is inspected, and if only a dermal bleeding point is found, with no hematoma, then the source is sutured under local anesthesia. This maneuver can be performed in the emergency room. Local digital compression or applying hemostatic sponge generally does not stop the bleeding. Compressive dressings are to be avoided, as they can stop the blood flow through the fistula. There are also larger sources, with a higher flow and a life-threatening potential. They are usually found at the site of the anastomosis or a slipped vessel ligature and are accompanied by a hematoma. [(86)]

Hematoma formation:

Hematoma with or without associated active bleeding, can demand surgical exploration of the wound. There are several situations that can be encountered. A hematoma with no active bleeding through the sutures may not impart on the fistula's functionality. If the hematoma is small and the AVF's thrill is present, there is no surgical indication and the patient is routinely monitored. If the hematoma is larger, and the thrill is modified or absent, the hematoma must be evacuated, followed by closing the bleeding source and AVF repermeation. Sometimes, removing the hematoma can bring back the thrill; if this does not occur, thrombectomy of the AVF or even construction of a new AVF should be performed. [(87)]

Chronic complications:

These are complications that occur days or months after the construction of an AVF as :

Thrombosis:

Thrombosis is caused by inadequate flow through the fistula, which leads to stasis. Causes of inadequate flow are discussed earlier. Other causes include intimal hyperplasia of the anastomosis, thrombosis of a venous pseudo aneurysm with consecutive thrombosis of the whole vein and extrinsic compression of the vein during its maturation period (for example, during sleep). [86]

If the patients present promptly, an attempt to salvage the fistula can be made via a surgical thrombectomy with a Fogarty catheter; if the vein has aneurysmal changes, it is probably not amenable to surgical treatment. If the fistula is unsalvageable, a new one must be constructed under the protection of a temporary hemodialysis catheter. [82]

Anastomotic pseudo aneurysm:

It is a rare complication with severe consequences, which requires emergency surgery. A pseudotumoral, pulsatile mass appears at the level of the incision used to create the fistula; this mass is tender, increasing in size and may be painful. The overlying skin has inflammatory and necrotic modifications. A septic process is quite always involved, which disrupts the anastomosis. The origin of the infection can be intraoperative or a clinically silent infection in a patient wearing a HD catheter. The main risk is of overlying skin necrosis with massive bleeding. Surgical exploration is mandatory. Usually, a partially thrombosed false aneurysm is found, with partial anastomosis disruption. A fragment of the pseudoaneurysm's wall is sent for a bacteriological exam and a full course of antibiotics is given after the operation. [84]

Venous aneurysm:

It occurs in uncorrected hypertensive patients, months or years after fistula construction, irrespective of the fact that the fistula has or has not been used for HD. A Doppler examination of the aneurysm shows turbulent blood flow and parietal thrombus. The natural evolution of this complication is with total thrombotic occlusion or spontaneous rupture. Other associated processes are thrombophlebitis, infection, skin necrosis with imminent perforation and hyperdynamic syndrome that require surgical treatment. [88]

Venous pseudoaneurysm:

It develops due to a common mistake made in hemodialysis services, which is repeated punctures at the same site. In time, the arterialized vein can grow to impressive sizes; develop a false aneurysm with partial or complete thrombosis. After repeated punctures, the overlying skin undergoes fibrotic changes, followed by necrosis, with a high risk of disruption and massive bleeding. This potential course of events makes surgery mandatory as soon as possible. The most common intervention is fistula ligation, followed by creating a new fistula with a different vein. In selected patients, who have no aneurysmal thrombi on Doppler exam or on palpation, a reductional plasty of the aneurysm can be performed. The entire aneurysm is exposed through a longitudinal incision, followed by proximal and distal cross clamping and wedge resection of the anterior wall of the aneurysm. The vein is rebuilt with a 7-0 Prolene continuous suture. The proximal segment of the vein can be used for hemodialysis after 36 hours and the dissected segment, after 3 weeks. [84]

• Skin necrosis:

It develops at the site of repeated vein punctures. It occurs after superficialization of a basilic or brachial vein, if the wound had been closed with a thin layer of skin overlying the fistula. This heals poorly between hemodialysis sessions, as it has an

inadequate blood supply, and becomes even thinner and necrotic; the venous wall is also thin and very fragile. Bleeding is the risk with this complication, and can be massive, life-threatening due to the high flow through the fistula. Surgical treatment involves the bleeding point skin suture, then making a circular incision around the necrotic segment and carefully dissecting it away from the vein, without entering the vein. [84]

Then the hemostasis can be easily performed with a 5-0 Prolene suture and the necrotic skin removed. The skin is then approximated with interrupted Prolene sutures. If bleeding occurs, the assistant compresses the fistula at the anastomotic level and proximally, on the arm, until hemostasis has been performed with interrupted 5-0 Prolene sutures. [84]

Steal syndrome

It is the most serious complication of vascular access surgery. The patients have all the clinical manifestations of chronic limb ischemia: muscular atrophy of the thenar and hypothenar eminences with functional impotence of the fingers,cold extremities, pain at rest, which becomes excruciating during HD sessions. Gangrenous changes of the fingers are sometimes present. [89]

The patient is usually diabetic and has atherosclerotic lesions distal to the anastomosis. Blood flow is diverted through the vessel with a lower resistance, which is the vein – the “steal syndrome”. Under normal conditions, when the radial artery is used for the fistula, the hand is still supplied with blood via the ulnar artery and the vascular arcades of the hand. However, there are cases when the arcades have clinically silent lesions (i.e. negative Allen test), which become significant if the distal radial artery is interrupted while constructing the AVF. This is why we attempt to maintain the distal radial artery open after creating the fistula. Hand ischemia can also occur if the brachial artery is used and is usually more

serious. [90]

This complication is much less common with autogenous AVF compared to prosthetic graft. All attempts should be to salvage the limb firstly, and the fistula, secondly. The most direct and simple technique is outflow ligation. The vein is exposed close to the anastomosis and doubly ligated with a number 5 Nylon tape. The thrill should disappear and distal perfusion is immediately improved, with quick remission of symptoms. The major drawback is that the AVF is lost for further access. [90]

Other AVF preserving techniques aim to decrease the flow through the fistula. These are banding of the vein, prosthetic graft interposition (PTFE) and venous by-pass using the accessory radial vein. These techniques will be discussed in the hyperdynamic syndrome paragraph. [84]

The DRIL procedure (Distal Revascularization IntervalLigation) has been described by Schanzer in 1992 (Schanzer et al, 1992). The artery is ligated distal to the anastomosis. An arterio-arterial by-pass is performed between the proximal artery (usually, the brachial artery) and the distal arterial territory (usually, the radial artery). Immediate technical success rates are excellent, with an overall reduction in ischemic events; however, if graft failure occurs, the entire distal extremity is at risk of gangrene and may require amputation. [91]

Hyperdynamic syndrome:(Circulation failure)

It is a consequence of greatly increased blood flow through the fistula, with consecutive volume overload of the right heart and cardiac failure. It is a relatively rare complication and can occur irrespective of the age of the fistula. It is associated with brachial artery use, which has a larger diameter and thus a higher flow (1-1.1 L/min) when compared to the radial artery (0.65 L/min) [92]. After the maturation period, Doppler examinations show flows of 8-10 L/min through the fistula. Local examination shows venous dilatations and the patients are restless

and show dyspnea, orthopnea and sinus tachycardia [93].Almost all of them are hypertensive, with uncorrected BP values in spite of treatment. The aim of the surgical treatment is to decrease the flow through the fistula.As previously stated, there are also techniques which aim to preserve the AVF. Banding the vein decreases the vein's diameter and thus increases the resistance flow and decreases the flow. The vein is dissected and encircled with a tape which is progressively tightened until the thrill becomes less intense, the heart rate drops below 100 beats/minute and the dyspnea gets clinically better. It is sometimes difficult to establish a precise amount of banding that prevents the steal syndrome but still allows fistula patency. In the setting of reduced flow that results from fistula banding, thrombosis can occur with further transient flow decrease, for example in hypotensive states. [94]

Prosthetic graft interposition uses PTFE graft, which obviously has a much smaller diameter than the arterialized vein and thus a higher resistance. A 4-5 cm segment of the vein is dissected; 3-5 cm is removed and the graft is interposed via 2 end-to-end anastomoses. Approximating the end of the vein and the graft can be difficult, due to the difference in size.Alternatively, the vein can be left in place and the graft sutured via 2 end-to-side anastomoses, followed by ligating the fistula between the 2 anastomoses. This eliminates the size-mismatch. The surgeon must resist the urge of using a larger graft, as this does not reduce the flow in a significant manner. [84]

Hand edema:

It is a relatively frequent, but usually transient complication in vascular access surgery. It is more frequent when the superficial veins have been used up and a brachiobrachial fistula is constructed. Venous hypertension occurs shortly after AVF creation, but it diminishes after collaterals develop and outflow improves. Outflow obstruction due to stenosis of a central vein provoked by a long-term

indwelling catheter or by neointimal hyperplasia from the turbulent flow of the AVF also cause venous hypertension. Sometimes, venous tributaries become dilated, incompetent and perfuse retrograde toward the forearm and the hand, thus increasing the capillary pressure. If the hypertension does not subside, it is accompanied by the classic symptoms of a venous stasis syndrome: edema, pigmentation and ulceration. The whole upper extremity canbecome involved in the edema, which sometimes includes the chest wall and the breast. A rich collateral venous circulation also develops. There are rare cases when the edema is so important that it produces ischemic phenomena. Treatment consists of repair of the fistula outflow or ligation of the fistula; improvement is immediate and dramatic, with edema reduction and healing of ulcerations within 1-2 weeks. [84]

Infection:

It should be a rare complication. If intraoperative contamination occurs, after a short period of time the wound becomes inflamed, painful, with purulent discharge, accompanied by fever. Vascular access creation is forbidden in a patient who carries a HD catheter but presents with fever and leucocytosis; in this case, the anastomosis becomes infected due to bacteremia and is extremely susceptible to disruption. These patients should be postponed until a new catheter is implanted in a different site and the old catheter removed and its' tip sent for bacteriological examination, followed by proper therapy. The most common infectious agents encountered are S.aureus and S. epidermidis. Reinterventions for bleeding or fistula thrombosis also increase the risk of infection. The higher the number of reexploration, the higher is the chance of acquiring an infection. For this reason, we believe that the maximum number of reinterventions is 2 in 24 hours. If the fistula is not functional after these 2 reinterventions, we wait until the incision heals before trying to create a new fistula using the same incision. [95]

Late anastomotic pseudoaneurysm formation is also a septic complication which can develop even if the incision is healed. If the wound shows a purulent discharge, the patient must be evaluated by a vascular surgeon. There are 2 therapeutic options. The conservative one is drainage of the collection,followed by washing with an antiseptic solution. A more aggressive option is closure of the fistula, also followed by antiseptisation of the wound. For a radio-cephalic fistula, the radial artery can be ligated without any ischemic consequences.For a fistula using the brachial artery, the fistula must be closed and arterial reconstruction performed. In the setting of acute bleeding, with fragile arterial wall, arterial ligature is mandatory; ischemic phenomena may occur, but this is not rule. In all cases, antibiotic therapy is indicated. **(84)**

AVF-related infections are more common in case of prosthetic grafts. Infections in autogenous fistulae respond to antibiotics most of the times unlike grafts where partial or complete excision of the prosthetic material is required. **(96)**

Venous stenosis:

Venous stenosis can occur at any level of the vein and can be corrected with a vein or PTFE patch angioplasty, a graft interposition depending on length, severity and other anatomical considerations, as well as the surgeon's preference or to create an entirely new anastomosis few centimeters up the artery.Late thrombosis is more common in prosthetic grafts. Stenosis at graft venous anastomosis due to intimal hyperplasia is the most common cause. The etiology of Intimal Hyperplasia (IH) is unknown, however, high shear stress will denudate the endothelial layer, resulting in platelet adhesion and initiation of a cascade of proteins that stimulate the smooth muscle cells to proliferate and migrate. **(96)**

Relevant stenosis:

Stenoses should be treated if the diameter is reduced by >50% and is accompanied with a reduction in access flow less than 500ml sec. Other indications

for stenosis treatment are difficulties in cannulation, painful arm oedema, prolonged bleeding time after cannulation or after removal of the cannulae (due to high venous pressure) and hand ischaemia due to arterial inflow or distal stenoses. A stenotic lesion, due to intimal hyperplasia, is the most common cause for low access flow. In RCAV fistulae, 55–75% of these stenoses are located close to the AV anastomosis and 25% in the venous outflow tract. In brachial-cephalic and/or basilic AV fistulae, the typical location (55%) is at the junction of the cephalic with the subclavian vein and the basilic with the axillary vein, respectively. An arterial inflow stenosis >2 cm from the anastomosis is uncommon, but may endanger the flow in the AV fistula. [97]

Stenosis of the anastomotic area

Surgical treatment is indicated in stenosis of the anastomotic area located in the lower forearm. Alternatively, PTA is possible although its results are likely to be less long lasting. Primary interventional treatment is indicated in stenosis of the anastomotic area located in the upper forearm and in upper arm. Surgery should be considered in cases of early or repeated recurrences of the lesions. Dilatation or surgical revision of anastomotic stenosis in upper arm fistulae can cause steal syndrome and access-induced hand ischaemia. Careful dilatation up to 5 or 6 mm initially is recommended. Dilatation to >6 mm is rarely indicated. [97]

Venous outflow stenosis

PTA is the first treatment option in the outflow veins (cephalic/basilic). Junctional stenosis, of the superficial veins with the deep venous system, can also be treated If a stent is placed in the final arch of the cephalic vein, it must not protrude into the subclavian vein where it could induce stenosis and preclude future use of the distal (basilic, brachial and axillary)veins. [98]

It is controversial, whether long-segment stenosis should be treated

radiologically or surgically. While some authors recommend surgical intervention [77], either by graft interposition (Romero et al, 1986) or vein transposition, others recommend radiological intervention (Sugimoto et al, 2003). Studies proving the superiority of one of the two treatment options for the treatment of long-segment obstruction are not available. However, PTA of short-segment stenoses (<2cm) has a better outcome compared with long-segment stenosis (>2cm). [99]

Persistent stenosis: Some stenoses cannot be dilated by conventional balloon angioplasty. These 'hard' stenoses can be treated with cutting balloons or ultrahigh pressure balloons (up to 32atm). [100]

Recurring stenosis: Recurring stenosis can be treated radiologically, with or without stent placement, or surgically [97]. The strategy for treatment should be made considering the individual condition of the patient in relation to the invasiveness of the surgical treatment. In spite of complete opening of the PTA balloon of sufficient diameter, the dilated vessel wall may collapse immediately after removal of the balloon. This elastic recoil can be prevented by stent implantation, especially in central veins. Stent placement in the needling areas of forearm fistulae should be avoided except PTA-induced ruptures not controllable by protracted balloon inflation. [101]

Venous hypertension:

Venous hypertension to the hand occurs more often (15- 20%) with a side-to-side AV fistula than with venous end to arterial side-type fistula but can also occur with the later type from back flow through a dorsal branch to the hand, especially if there is a more proximal stenosis in the cephalic vein or central venous obstruction. The end result is venous insufficiency in the limb presenting as edema, pigmentation, thickened skin and, in severe cases, ulceration. Depending upon the cause of venous hypertension, treatment is done by ligation of the venous

tributary responsible for retrograde flow or by angioplasty to correct stenosis. This situation needs correction only when the patient develops pain and/or ischemia. [96]

AV fistulas, both autogenous and grafts may develop such high blood flow that congestive heart failure develops. This is perhaps more likely to occur with non-tapered PTFE grafts. The blood flow through the fistula is decreased by some sort of “banding” procedure; in this case, a 2 cm segment of a 6 mm PTFE graft was sutured around the vein to partially occlude the vein close to the anastomosis. [96]

Patients and Methods

The current prospective randomized controlled study included 60 patients with a clinical diagnosis of end-stage renal failure (ESRF) requiring hemodialysis. Thirty patients were operated upon by saphenous graft for brachio-axillary shunt while the other thirty patients were operated upon by synthetic graft (PTFE) for brachio-axillary shunt.

Patients included in this study were recruited from general surgery department (vascular surgery unit), Benha university hospital.

Patients included in this study were between the ages of 18 and 80 years. They were admitted or referred to the department, with a diagnosis of end-stage renal failure (ESRF) requiring hemodialysis. Patients were lacking suitable venous system for natural AVFs in both upper limbs, or failed previously done AVFs.

Patients excluded from this study were those who had absence of radial or ulnar artery pulses, less than three mm diameter of the brachial artery, less than three mm diameter of axillary vein, thrombosed axillary vein, patients with heart failure or chronic hypotension were also excluded. patients who refused to be included in study or refused to sign the informed consent were also excluded. Patients refused to undergo Ultrasound-supraclavicular block or with history of hypersensitivity reaction to local anesthesia or coagulation disorder were also excluded. Patients with great saphenous vein disease or less than 3 mm diameter were excluded from GSV grafting.

Enrollment of eligible patients began on March 2018 and took place till February 2019. Follow up was designed for 1st, 6th and 12th months duration.

The participants who agreed to share in this clinical study gave informed consent after being fully informed about the technique and its circumstances. The study had been conducted after approval of the Committee of Ethics in Faculty of Medicine, Benha University.

Preoperative assessment

History taking: The patients who had be included in the study had been interviewed to ascertain their clinical histories including presenting symptoms; duration of symptoms; and history and nature of trauma or tumor, previous surgery, and chronic illness. History taking included also :history of central venous catheter placement to exclude the possibility of central venous thrombosis or stenosis, the dominant arm: To minimize the negative impact on the quality of life as the use of the non-dominant arm is preferred, history of sever congestive heart failure which may alter the hemodynamic and cardiac output, history of arterial or venous peripheral catheter as this may damage target vasculature, history of anticoagulant therapy or any coagulation disorders, presence of co-morbid conditions that may limit patient life expectancy; as morbidity associated with placement and maintenance of vascular access may not justify their use in some patients, history of vascular access; as previously failed vascular access will limit available sites and causes of previous failure may influence the plan, anticipated kidney transplantation: as catheter access may be sufficient ,history of modified radical mastectomy should defer the ipsilateral limb from being used as a site for AV access.

Clinical examination: All patients had undergone clinical examination to assess general health and presence of systemic disease. This also included physical examination of the arterial system which includes assessment of: Character of peripheral pulse, as an adequate arterial system is needed for the access and the quality of arterial system will influence the choice of the access site, bilateral arm blood pressures which determine suitability of A-V access. Physical examination of the venous system included evaluation of edema and differential arm size which indicate venous outflow problems that may limit potential access sites, examinations of collateral veins as collateral veins are indicative of venous obstruction, examination for previous central or peripheral venous catheterization that may lead to central venous stenosis or may damage target venous vasculature. Cardiovascular evaluation was done as evidence of heart failure may alter cardiac output affecting success of access construction.

Investigations: All patients had done routine preoperative work up in the form of Complete blood count, liver and kidney functions tests, Coagulation profile, ECG and ECHO if needed. Also, all patients had done Duplex US for evaluation of arterial system of both upper limbs which include pulse examination, differential blood pressure measurement, assessment of the arterial diameter and the presence of arterial calcification as presence of main arterial stenosis proximal or distal to the planned site for AVF may lead to failure of the access or steal respectively. Venous duplex evaluation is done for assessment of patency and diameter of axillary vein and exclusion of presence of central venous stenosis. Venography was done for patients with edema in the limb in which an access site is planned, collateral vein development in any planned access site ,current or previous subclavian catheter placement of any type in venous drainage of planned

access . Saphenous mapping of both lower limbs to determine diameter of the vein, exclude thrombophlebitis and ensure patency of the vein was done to all patients.

Management

After doing routine preoperative work up, using a standard protocol. All operations had been carried out under ultrasound-guided supraclavicular block anesthesia or with local anesthesia with sedation. Spinal or local anesthesia had been used in the first group to harvest great saphenous vein graft. Preoperative antibiotics will be given to all patients.

For the first group: The patients were laid down in the supine position and one thigh (usually contra-lateral thigh) was scrubbed with also the arm and forearm (non dominant hand is the 1st choice). Starting with GSV dissection in the thigh, marked preoperatively by CD marker,harvesting a sufficient length corresponding to length of the arm from the axilla to the elbow after ligation of its tributaries, doing hydro-dilatation of the vein and then closure of the thigh incision in two layers. (Fig. 1) Through a longitudinal axillary incision, dissection and control of the axillary vein, proximally and distally, was done for a sufficient length to allow a longitudinal venotomy of around 1.5 cm, then through a longitudinal incision just above elbow crease, the brachial artery was dissected and controlled both proximally and distally. In most of the cases, distal anastomosis was done first anchoring the upper end of GSV with the axillary vein usually by prolene 6/0 (Fig. 2), then after testing patency of the anastomosis with saline heparin injection, a control of GSV just above the venous anastomosis was done by a delicate Boldog forceps allowing reestablishment of venous return through the axillary vein. Then,

GSV was tunneled subcutaneously in the lateral side of the arm(distal end anastomosed distally to the artery and the proximal end anastomosed to the vein) using long artery forceps and its lower end then anastomosed to the brachial artery by prolene 6/0 (Fig. 3). Arterial and graft controls were then released and blood flow was allowed to fill the graft and axillary vein. A palpable thrill was felt over the graft. Patients should receive systemic anticoagulation with 80 IU/kg non-fractioned heparin. Closure of both the axillary and brachial wounds in 2 layers was performed and the patients were given another dose of antibiotic after 12 hrs from the first dose in the theatre

For the second group: The patients were laid down in the supine position then arm and forearm were scrubbed (non-dominant hand is the 1st choice). Through a longitudinal axillary incision, dissection and control of the axillary vein, proximally and distally, was done for a sufficient length to allow a longitudinal venotomy of around 1.5 cm, then through a longitudinal incision just above elbow crease, the brachial artery was dissected and controlled both proximally and distally .PTFE graft had been anastomosed end-to-side to the brachial artery and axillary vein using polypropylene 6/0 continuous sutures. Patients then received systemic anticoagulation with 80 IU/kg non-fractioned heparin. Closure of both the axillary and brachial wounds in 2 layers had be performed and the patients had been given another dose of antibiotic after 12 hrs. from the first dose in the theatre.

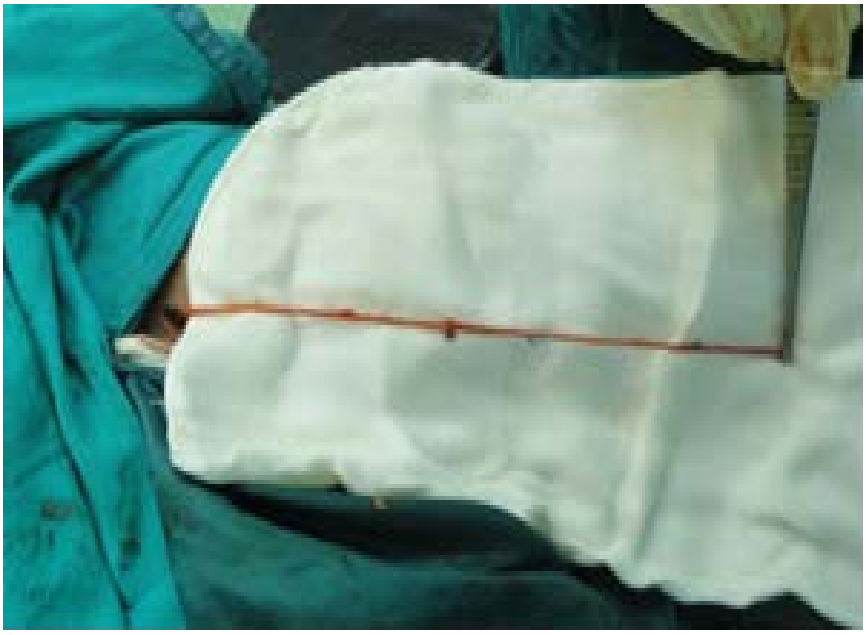


Fig (9) : GSV harvesting

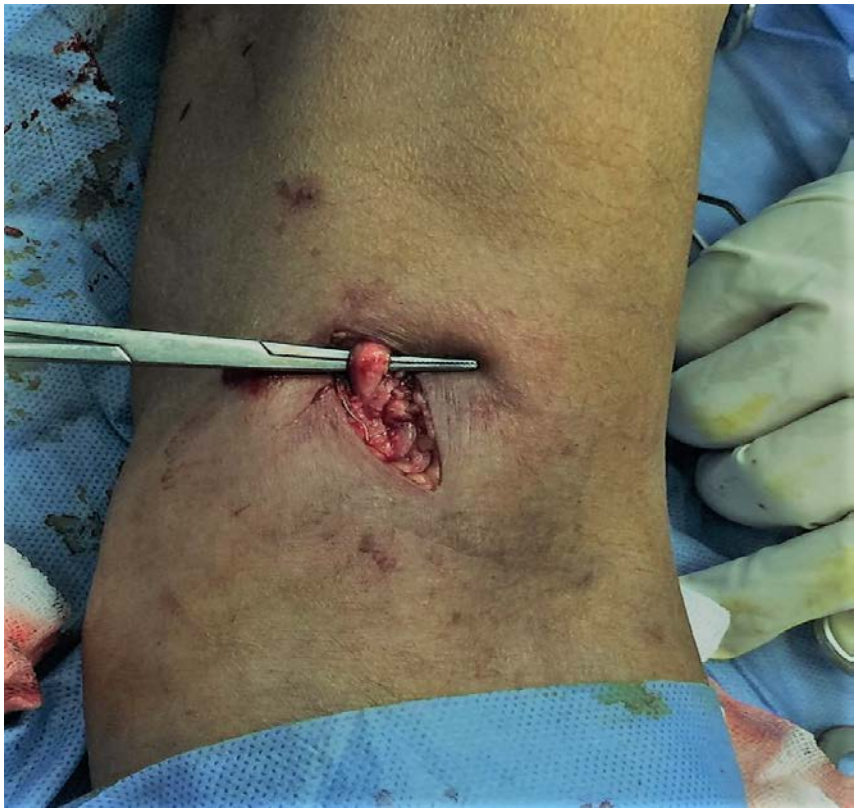


Fig (10): Brachial artery exposure above cubital fossa

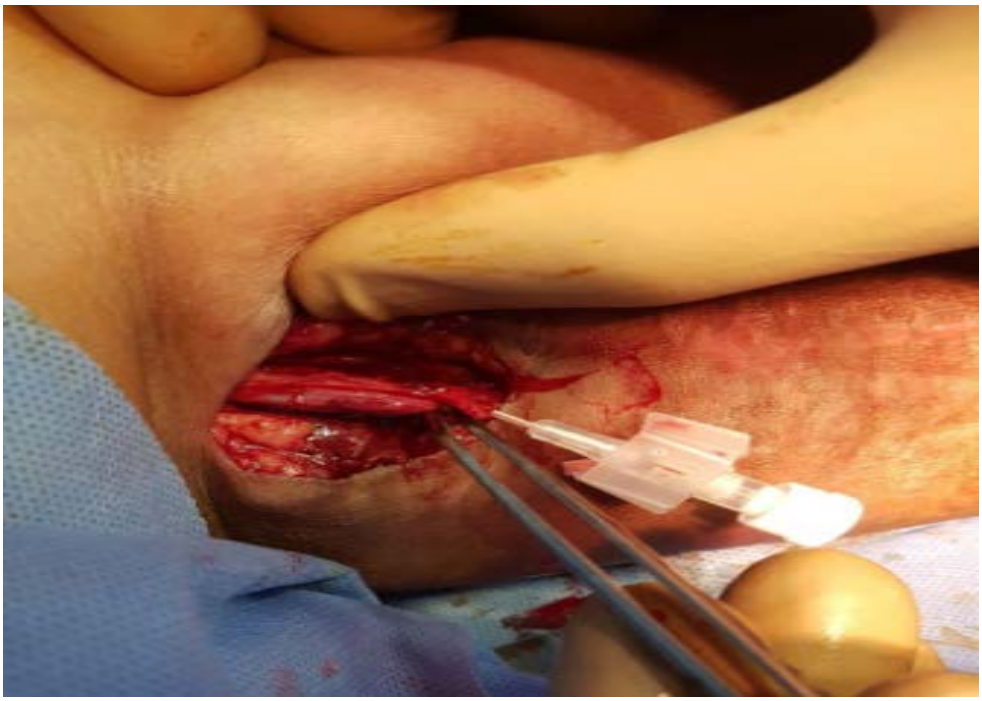


Fig (11):axillary vein exposure and cannulation

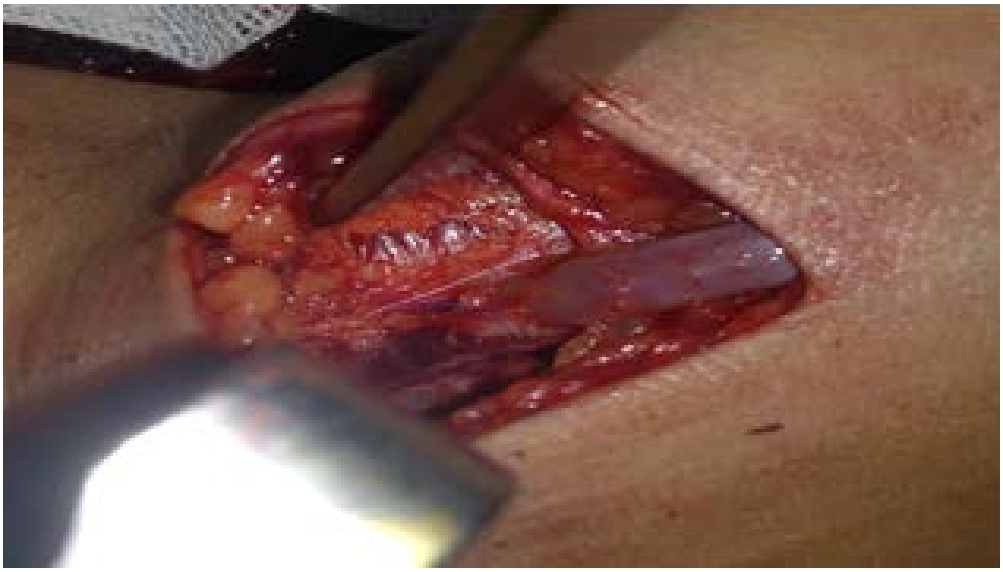


Fig (12): GSV anastomosed to brachial artery

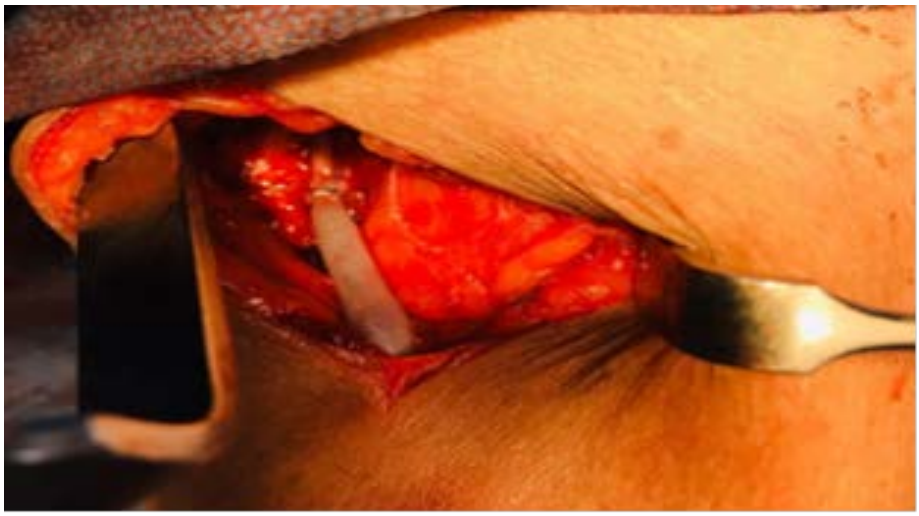


Fig (13): GSV anastomosed to axillary vein

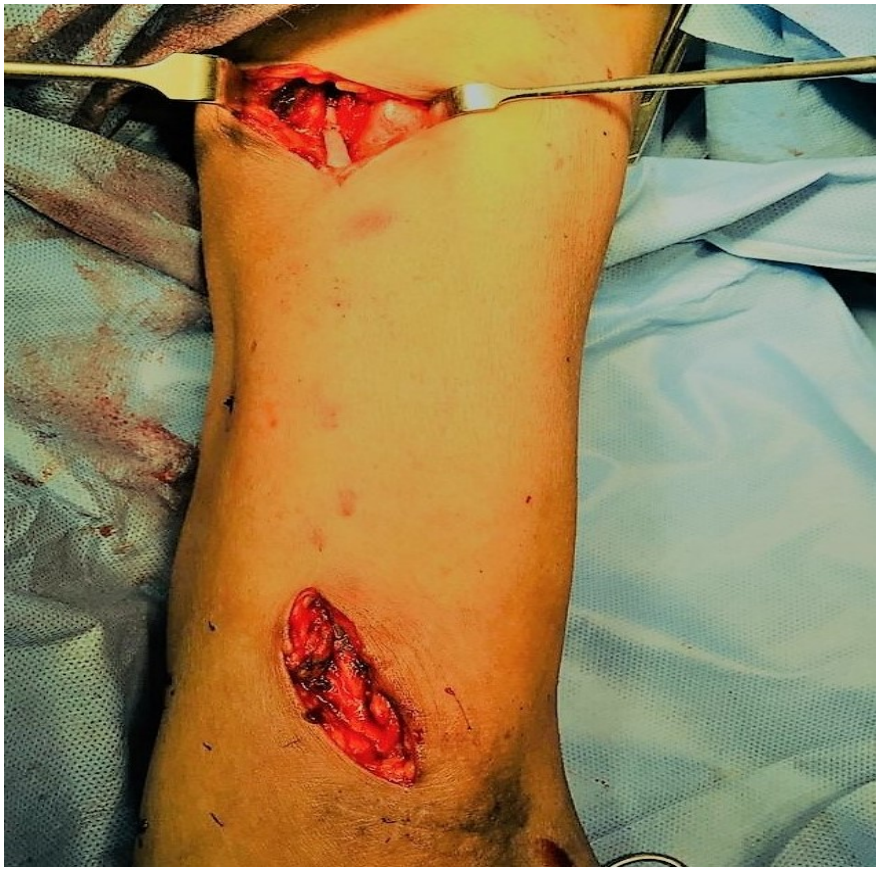


Fig (14): GSV anastomosed to axillary vein and brachial artery

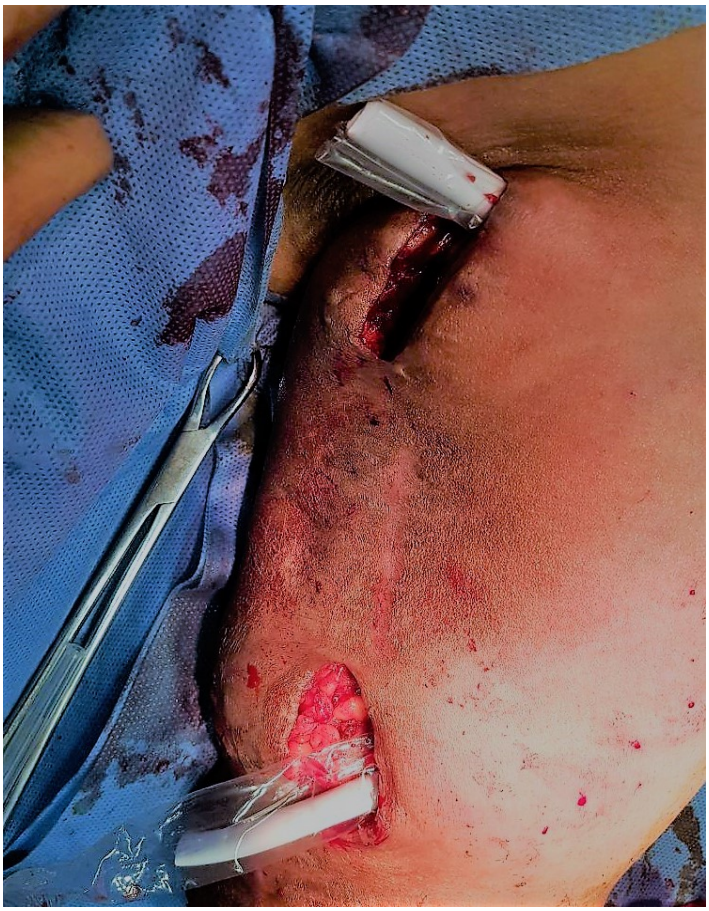
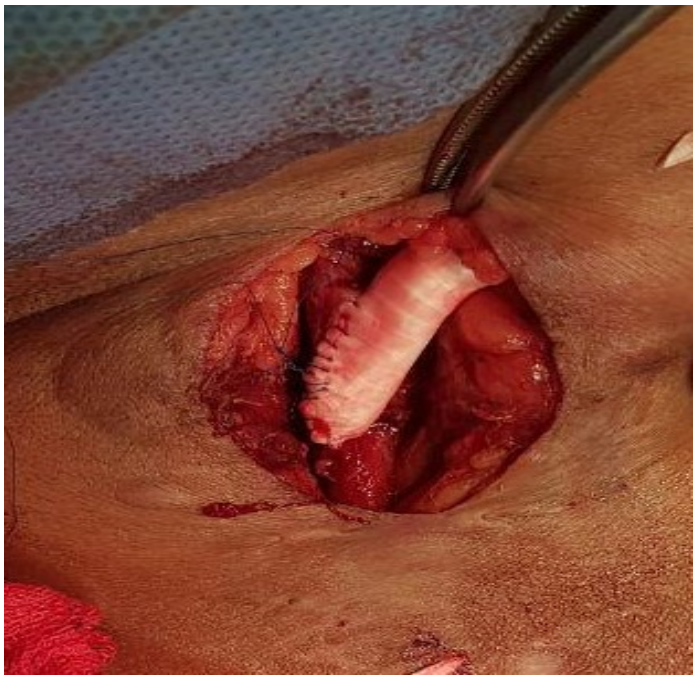
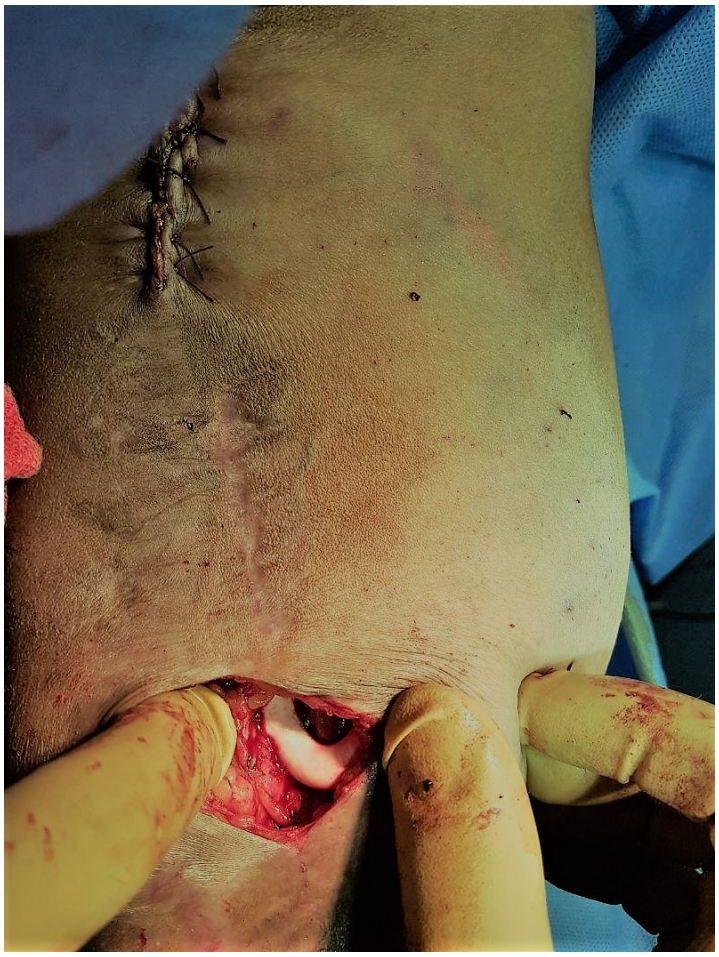


Fig (15): PTFE graft tunneled and appear through the 2 incisions



Fig(16):PTFE graft anastomosed to axillary vein



Fig(17):PTFE graft anastomosed to brachial artery

In all groups the following features are studied:

1. Age.
2. Gender.
3. Co-morbidities as diabetes mellitus, hypertension, ischemic heart disease.
4. Type of anesthesia (local, spinal, supraclavicular block)
5. Amount of blood loss. (in ml)
6. Duration of the surgery. (in minutes)

7. Patency rate of both grafts. (primary, assisted primary, secondary patency)

   -Primary patency is the interval between the time of access placement and any intervention designed to maintain or reestablish patency, access thrombosis, or the time of measurement of patency.

   - Assisted primary patency is the interval between the time of access placement and access thrombosis or the time of measurement of patency, including any intervening surgical or endovascular manipulation.

   -Secondary patency is the interval between the time of access placement and access thrombosis, access abandonment, or the time of measurement of patency, including any intervening surgical or endovascular manipulations designed to reestablish functionality after access thrombosis

8. Time required to start hemodialysis from grafts. (maturation:flow rate in the graft 400ml or more , vein diameter at least 6 mm)
9. Complications which may be intraoperative as bleeding, thrombosis, anesthesia complications or postoperative complications as

   - hematoma formation

   - thrombosis,

   -aneurysm : is seen adjacent to the anastomosis associated with hemodynamically significant stenosis, within cannulation areas, adjacent to stenoses midaccess, or next to vein junctions, valves, or rigid areas caused by prior catheters.

   -Pseudoaneurysm: develop due to trauma from repeated punctures or poor technique, with resultant perigraft hematoma formation in addition to increased intragraft pressures associated with outflow stenoses, most are related to cannulation.

   - Infection which is graded as follows

   Grade 0: None

   Grade 1: Resolved with antibiotic treatment

Grade 2: Loss of AV access because of ligation, removal, and bypass

Grade 3: Loss of limb,

-Hematoma , seroma : these fluid collections can be graded as follows:

Grade 0: No collection

Grade 1: Observed, resolved

Grade 2: Involves aspiration or surgical drainage

Grade 3: Results in loss of the graft

-Steal syndrome which is graded as follow:

Grade 0: No symptoms

Grade 1: Mild—cool extremity, few symptoms, flow augmentation with access occlusion

Grade 2: Moderate—intermittent ischemia only during dialysis,claudication

Grade 3: Severe—ischemic pain at rest, tissue loss

-Venous hypertension

-Hyperdynamic circulation, lymphorrhea, venous stenosis.

-Neuropathy

10. Duration of hospital stay.

Statistical analysis

The collected data were tabulated and analyzed using SPSS version 19 software (SpssInc, Chicago, ILL Company). Categorical data were presented as number and percentages, Chi square (χ^2) and Fisher's exact tests were used to analyze them. Quantitative data were tested for normality using Shapiro-Wilks test assuming normality at $P>0.05$. Normally distributed variables were expressed as

mean ±standard deviation and analyzed by Student "t' test for 2 independent groups, while non parametric data were presented as median and inter-quartile range (IQR), and analyzed by Mann Whitney U (Z_{MWU}) test. P ≤0.05 was considered significant.

P value >0.05 is non significant (NS)

P<0.05 is significant (S)

P≤0.001 is highly significant (HS)

Mean =

Is the sum of the values in a set of data divided by the number of the values in the set. It is denoted by the sign X (called X bar).

$$\bar{X} = \frac{\sum X}{n}$$

Where: *X* *denotes any value of observation.*
$\sum$ *the Greek capital letter sigma, means the sum of.*
n *The number of observations.*

Standard deviation (SD):

It is the positive square root of the variance.

Variance = $\mathbf{S^2}$

The sum of the squares of the deviation of each measurement in a series from the mean of the series, divided by the total number of the observation minus one.(The degree of freedom).

$$S^2 = \frac{\sum \text{Squared deviation of the mean}}{n-1}$$

$$S^2 = \frac{\sum (X - \bar{X})^2}{n-1}$$

Median = middle value of the ordred data

(N+1)/2 if sample size is odd

n/2& (n/2)+1

if sample size is even

Inter Quartile Range (IQR) = 25th -75th percentiles

middle 50% of the values in the ordered data

Chi square test

$$X^2 = \frac{\sum (O - E)^2}{E}$$

Where O is the observed value

E is the expected value

It compares between 2 or more categorical groups (tables 2x2 or more)

$$Expected = \frac{col.total \ x \ row \ total}{Grand \ total}$$

Fisher's exact testis used when you have two nominal variables. Fisher's exact test is more accurate than the chi-squared test when the expected numbers are small.

Student "t" test compares between 2 means of 2 independent groups.

t-value is the ratio of the difference between the two means/calculated SD of this difference.

$$t = \frac{\overline{X}1 - \overline{X}_2}{\sqrt{\frac{SD_1^{\,2}}{n_1} + \frac{SD_2^{\,2}}{n_2}}}$$

Where $\overline{X_1}$ = mean of group 1

X_2 = mean of group 2

SD_1 = Standard deviation of group 1

SD_2 = Standard deviation of group 2

n_1 = sample size of group 1

n_2 = = sample size of group 2

Mann Whitney U test:

non parametric test used to compare 2 non parametric quantitive variables.

Boxplots

A useful way of graphically representing the symmetry of data is the boxplot. This type of graph displays the median value by a horizontal bar surrounded by 50% of the scores shown within a box. This 50% of scores falls between the 25th and 75th percentile marks. The 25th percentile is at the bottom of the box and the 75th percentile is at the top. The whiskers extending from both ends of the box show the highest and lowest values that are not outliers. Outliers are scores in the distribution that are more than 1.5 box-lengths from the 25th or 75th percentile, and they are displayed by a circle; those that are more than 4 box-lengths away are shown by an asterisk. **(102) (103)**

Results

The study was conducted in Benha University hospitals. The current prospective randomized controlled study included 60 patients with a clinical diagnosis of end-stage renal failure (ESRF) requiring hemodialysis. Thirty patients were operated upon by saphenous graft for brachio-axillary shunt (group I) while the other thirty patients were operated upon by synthetic graft (PTFE) for brachio-axillary shunt (group II).

As regard Age, all patients had Age range from (50.8±2.5) in group I and (52.1±3.2) in group II. There was no significant difference could be detected between both groups with P-Value >0.05 as shown in **table (1) and Figure (18)**.

As regard gender, group I included 60% males and group II 6.7% males. There was no significant difference could be detected between both groups with P-Value >0.05 as shown in **table (1) and Figure (19)**.

Table (1): Distribution of the studied groups regarding their age and gender**:**

Variable		**Group I (n=30)**		**Group II (n=30)**		**St."t"**	**P**
Age (ys)	**Mean±SD**	50.8±2.5		52.1±3.2		**1.8**	**0.077 (NS)**
	Range	47-55		48-61			
		No.	**%**	**No.**	**%**	χ^2	**P**
Gender	**Male**	**18**	60.0	17	56.7	**0.07**	**0.79 (NS)**
	Female	**12**	40.0	13	43.3		

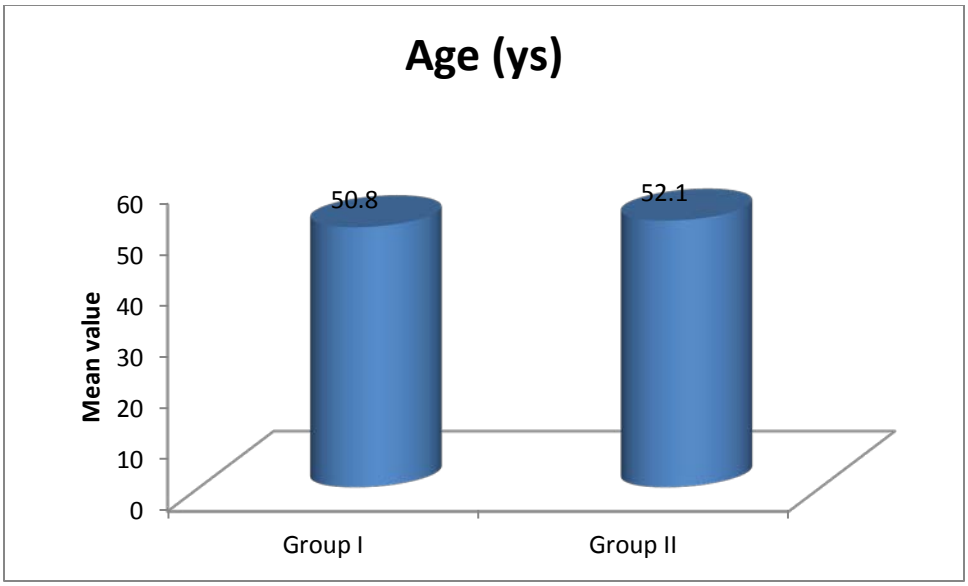


Fig (18): Bar chart showing age distribution among the studied groups

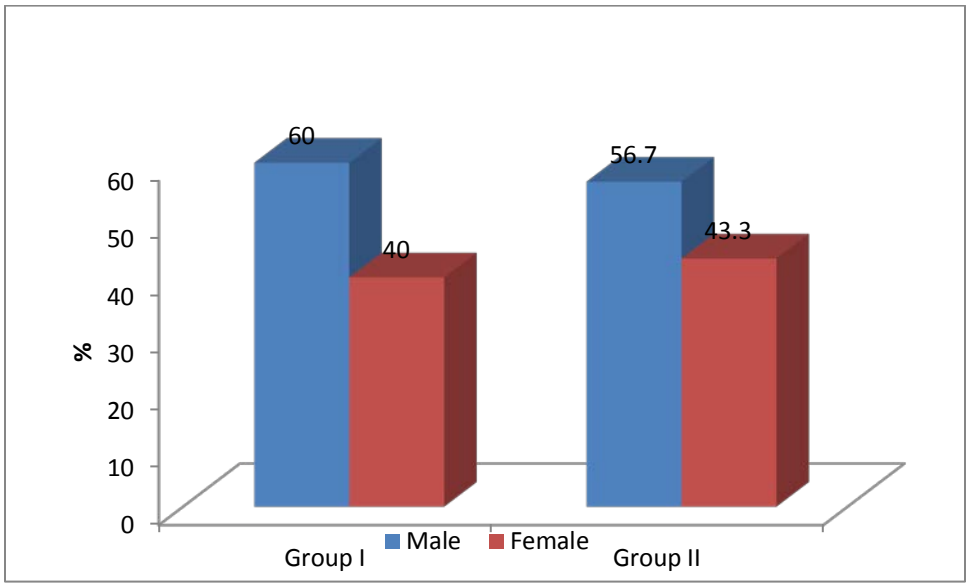


Fig (19): Bar chart showing gender distribution among the studied groups

In the saphenous group (I), 5 patients (16.7%) had diabetes mellitus, 8 patients (26.7%) had hypertension and 3 patients (10%) had ischemic heart diseases while in the synthetic group, 7 patients (23.3%) had diabetes mellitus, 6 patients (20%) had hypertension and 4 patients (13.3%) had heart diseases and this difference in

the associated diseases was not statistically significant (p value =0.52 for D.M, 0.54 for hypertension and 1 for heart disease) as shown in **table 2 and figure(11)**.

Smokers in group (I) were 5 patients (16.7%) while in group (II) were 6 patients (20%) and the difference is not statistically significant (P-Value >0.05).

Table 2: Distribution of the studied groups regarding their associated diseases (DM, HTN, IHD) and smoking habit:

Variable	Group I (n=30)		Group II (n=30)		χ^2	P
	No.	%	No.	%		
DM	5	16.7	7	23.3	**0.42**	**0.52 (NS)**
HTN	8	26.7	6	20.0	**0.37**	**0.54 (NS)**
IHD	3	10.0	4	13.3	**FET**	**1.0 (NS)**
Smoking	5	16.7	6	20.0	**0.11**	**0.74 (NS)**

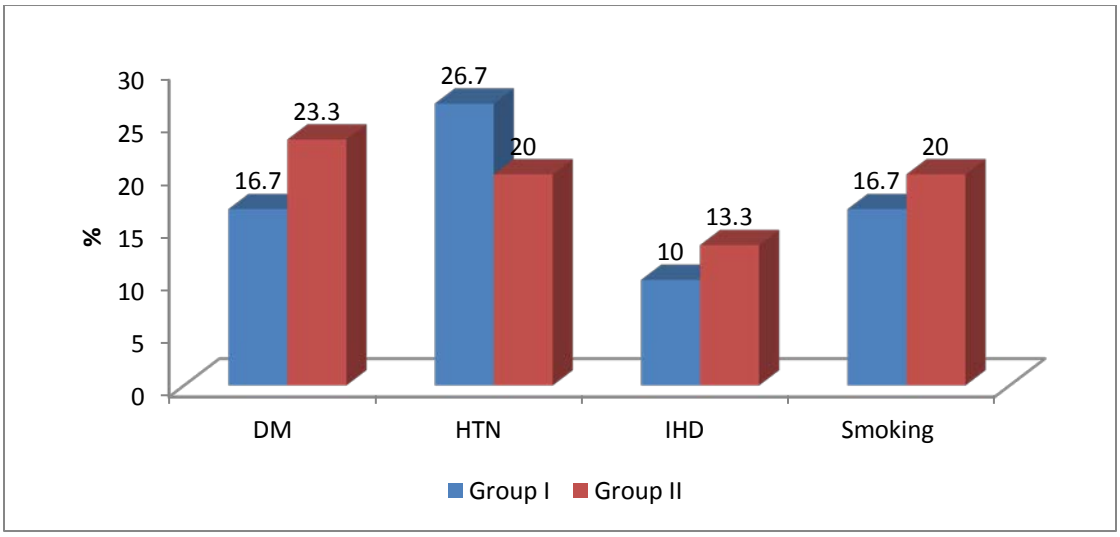


Fig (20): Bar chart showing the studied groups regarding their associated diseases (DM, HTN, IHD) and smoking habit

4 patients of group (I) and 3 of group (II) were given ASA score 4 and the rest of patients were given ASA score 3. There was no significant difference could be detected between both groups with P-Value >0.05.

In group (I), local anesthesia as only type of anesthesia was used in 10(33.3%) patients, local and spinal anesthesia are used in 14(46.7%) patients, supraclavicular block with spinal anesthesia are used in 6(20%) patients.

In group (II), local anesthesia as only type of anesthesia was used in 22(73.3%) patients, supraclavicular block is used in 8(26.7%) patients.There was significant difference in type of anesthesia could be detected between both groups with P-Value >0.05.

Table 3: comparison between the studied groups regarding their ASA score and type(s) of anesthesia used in the operation**:**

Variable		**Group I (n=30)**		**Group II (n=30)**		χ^2	**P**
		No.	**%**	**No.**	**%**		
ASA score	**3**	26	86.7	27	90.0	**FET**	**1.0 (NS)**
	4	4	13.3	3	10.0		
Type of anesthesia	**Local**	10	33.3	22	73.3	**35.4**	**<0.001 (HS)**
	Supraclavicular block	0	0.0	8	26.7		
	Local, spinal	14	46.7	0	0.0		
	Supraclavicular block, spinal	6	20.0	0	0.0		

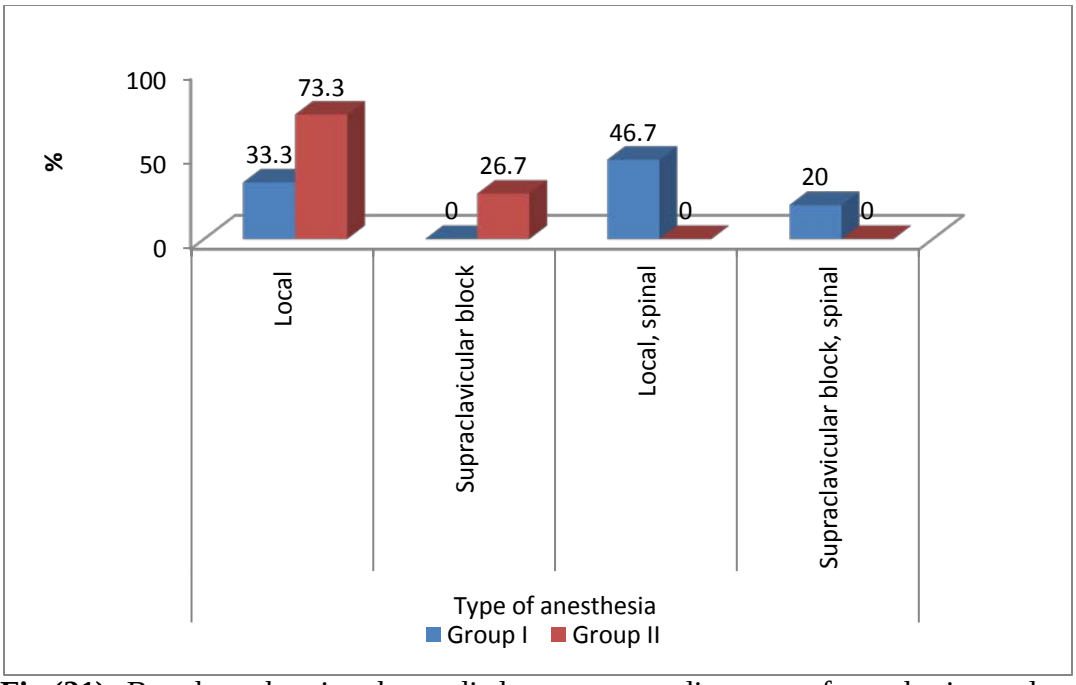


Fig (21): Bar chart showing the studied groups regarding type of anesthesia used

Mean total operation time was 120.7± 9.51 minutes and 91.0±2.04 minutes for the saphenous and synthetic group respectively that showed significant statistical difference (p value <0.001) as shown in **table 4**.The time for graft maturation was within a mean interval of 39.9± 7.71 days and 14.0± 2.04 days after the intervention for the saphenous and synthetic group respectively that showed significant statistical difference (p value <0.001) as shown in **table 4**.

Median blood loss was 200 ml and 125 ml in saphenous and synthetic group respectively which is statistically significant (p value <0.001).

There was no significant difference could be detected between both groups in hospital stay with P-Value >0.05.

Table 4: comparison between the studied groups regarding time taken for graft maturation, operative time, blood loss, and hospital stay:

Variable	Group I (n=30)			Group II (n=30)			St. 't'	P
	Mean	± SD	Range	Mean	± SD	Range		
Time for graft maturation (days)	39.9	7.91	27-53	14.0	2.04	10-18	17.3	<0.001 (HS)
Operative time (min.)	120.7	9.51	100-140	91.0	10.07	75-110	11.7	<0.001 (HS)
	Median	IQR	Range	Median	IQR	Range	Z_{MWU} test	P
Blood loss (ml)	200.0	150-250	100-300	125.0	100-150	100-250	4.45	<0.001 (HS)
Hospital stay (days)	1.0	1-2	1-3	1.0	1-1	1-2	1.0	0.32 (NS)

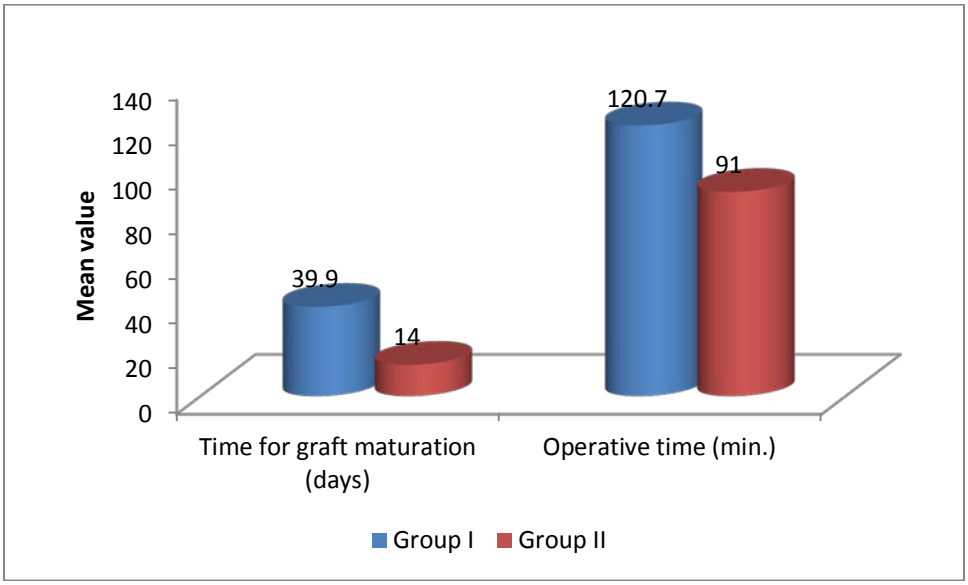


Fig (22): Bar chart showing the studied groups regarding time of graft maturation and operative time

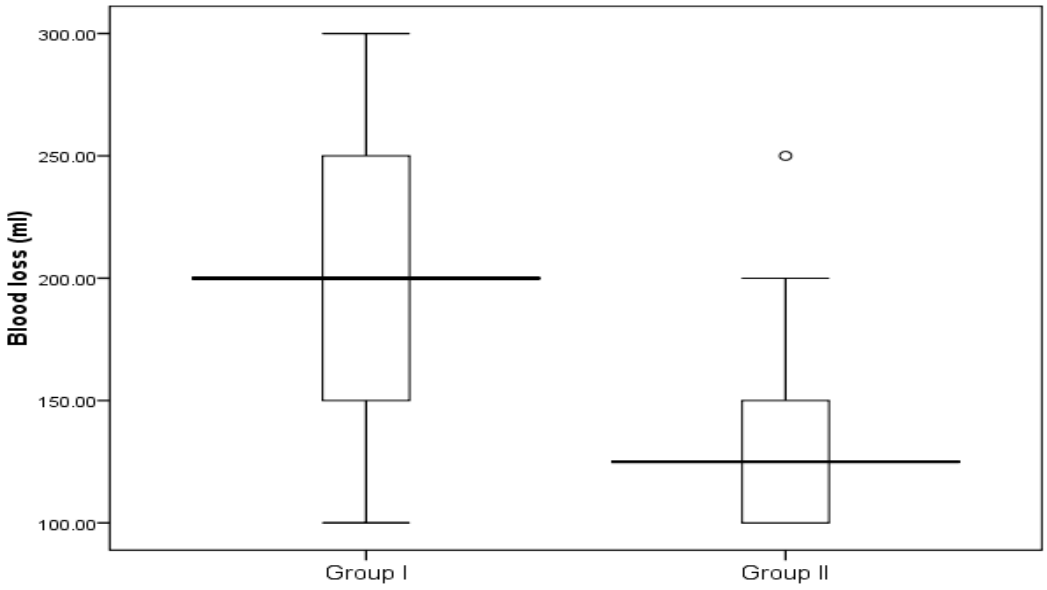


Fig (23): Box plot showing median and IQR of blood loss among the studied groups.

As regard complications, in group (I) graft thrombosis in group (1) occurred in 8 cases (26.6%) within 1-month, surgical thrombectomy was done for 7 cases and regained patency in 1 case and failed in 6 cases and 1 case refused the procedure. Further thrombosis in 4 cases (13.3%) in 6 months follow up had occurred for which surgical thrombectomy was done and regained patency in 1 case only. At 12 months follow up further thrombosis has occurred in 3 cases (10%) in which failed the trial of surgical thrombectomy.

On the other hand, in group (II) graft thrombosis had occurred in 3 cases (10%) within 1 month ,for which thrombectomy was done and regained patency in 1 case ,3 cases of further thrombosis within 6 months with failure of trial of thrombectomy to regain patency(1 case associated with pseudoaneurysm and

infection so graft is removed) and another 3 cases at 12 months follow up and thrombectomy was successful in 2 of the 3 cases.

Table 5: comparison between the studied groups regarding graft thrombosis**:**

Variable	Group I (n=30)		Group II (n=30)		χ^2	P
	No.	%	No.	%		
Thrombosis at 1 m	8	26.7	3	10.0	**2.78**	**0.095 (NS)**
Further thrombosis at 6 m	4	13.3	3	10.0	**FET**	**1.0 (NS)**
Further thrombosis at 12 m	3	10.0	3	10.0	**FET**	**1.0 (NS)**

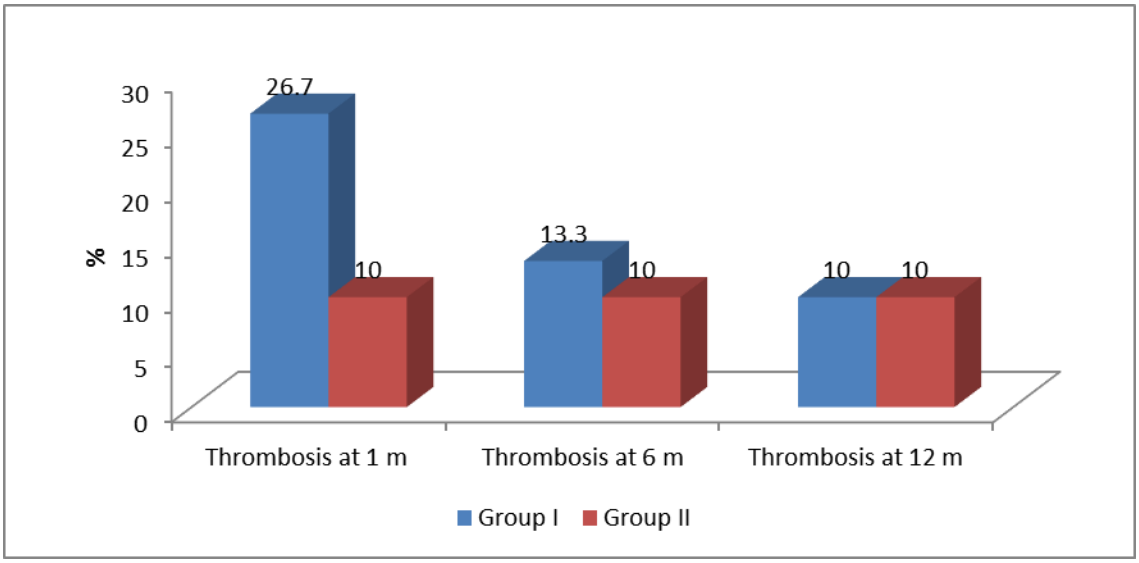


Fig (24): Bar chart showing the studied groups regarding graft thrombosis

Postoperative Hematoma (within 1st month) occurred in 3(10%) cases in group I and 2 cases (6.7%) in group II and all of them were grade 2 and treated conservatively except a case in group I which needed open drainage (grade 3).

Puncture site hematomas occurred in group I in 3 cases (10%) in 6 months (2 of them grade 1 and treated conservatively and a case of grade 4 hematoma associated with pseudoaneurysm and required ligation of the fistula)and then in 2 cases(grade 1) (6.7%) in 12 months compared to 4(13.3%)(3 of them grade 1 and a case of grade 4 associated with infection which caused loss of the graft) and 2(6.7%)(case of grade 1 and another of grade 4 associated with infection and caused loss of the graft) cases in group II in 6 and 12 months respectively with no statistical difference (P value >0.05).

Postoperative seroma occurred in 4(13.3%) and 5(16.7%) cases in group I and II respectively. Spontaneous resolution occurred in all cases of group I (grade 1) while a case of group II (grade 2) needed aspiration. There was no significant difference could be detected between both groups in with P-Value >0.05.

Lymphorrhea was observed in 4(13.3%) cases of group I 3 of them occurred in the GSV harvesting incision.2(6.7%) of group II patients had lymphorrhea. All cases had spontaneously resolved. There was no significant difference could be detected between both groups (P-Value >0.05).

Table 6: comparison between the studied groups regarding hematoma, seroma formation and lymphorrhea**:**

Variable		**Group I (n=30)**		**Group II (n=30)**		**P**
		No.	**%**	**No.**	**%**	
Hematoma	**At 1 m**	3	10.0	2	6.7	**1.0 (NS)**
	At 6 m	3	10.0	4	13.3	**1.0 (NS)**
	At 12 m	2	6.7	2	6.7	**1.0 (NS)**

Seroma	**At 1 m**	4	13.3	5	16.7	**1.0 (NS)**
	At 6 m	0	0.0	0	0.0	**----**
	At 12 m	0	0.0	0	0.0	**-----**
Lymphorrhea	**At 1 m**	4	13.3	2	6.7	**0.67 (NS)**
	At 6 m	0	0.0	0	0.0	**----**
	At 12 m	0	0.0	0	0.0	**-----**

Fisher's exact test was used

2 case of infection in group 1 required ligation of shunt(grade 2) (1 at 1 month and the other at 12 months) and 3 cases of GSV harvesting(grade 1) wound infection has required antibiotics and dressing , on the other hand 3 cases of graft infection(grade 2)(1 at 1 month , 1 at 6 months and the last one at 12 month follow up)are observed in group 2 and required graft removal and 3 cases of superficial wound infection(grade 1) treated by antibiotics and daily dressing.

Table 7: comparison between the studied groups regarding wound infection and dehiscence:

Variable		**Group I (n=30)**		**Group II (n=30)**		**P**
		No.	**%**	**No.**	**%**	
Infection	**At 1 m**	4	13.3	3	10.0	**1.0 (NS)**
	At 6 m	0	0.0	2	6.7	**0.49 (NS)**
	At 12 m	1	3.3	1	3.3	**1.0 (NS)**

Wound dehiscence	**At 1 m**	3	10.0	2	6.7	**1.0 (NS)**
	At 6 m	0	0.0	0	0.0	----
	At 12 m	0	0.0	0	0.0	-----

Fisher's exact test was used

A case of venous aneurysm occurred in group (I) after 5 months which required surgical revision with use of interposition graft.

3 cases had developed pseudoaneurysm were observed in group 1 in 1 month follow up, 1 of them associated with infection and bleeding and required ligation of the fistula while the others didn't need any intervention. Another 2 cases of pseudoaneurysm development associated with infection and bleeding had occurred at 6 and 12 months follow up which required ligation of fistula. In group II pseudoaneurysm in a case in the 1st month postoperatively with no intervention needed, while other 2 cases at 6 and 12 months follow up had needed removal of the graft due to pseudoaneurysm associated with infection and recurrent bleeding.

Table 8: comparison between the studied groups regarding aneurysm and pseudo-aneurysm formation**:**

Variable		**Group I (n=30)**		**Group II (n=30)**		**P**
		No.	**%**	**No.**	**%**	
Aneurysm	**At 1 m**	0	0.0	0	0.0	-----
	At 6 m	1	3.3	0	0.0	**1.0 (NS)**
	At 12 m	0	0.0	0	0.0	--------
Pseudo - aneurysm	**At 1 m**	3	10.0	1	3.3	**0.61 (NS)**
	At 6 m	1	3.3	1	3.3	**1.0 (NS)**
	At 12 m	1	3.3	1	3.3	**1.0 (NS)**

Fisher's exact test was use

Steal is observed in 2 cases of group 1, a case of grade 1 steal which didn't required any intervention and the other case was grade 2 and required flow limiting procedure in the form of suture plication. In group II 3 cases of steal syndrome has occurred postoperatively 2 of them was grade 1 and needed just observation and the other case was grade 3 when the patient had rest pain and DRIL procedure was done to him to save his limb.

Venous hypertension in a case of group 1 is observed postoperatively as upper limb edema during and after dialysis but resolved spontaneously,in group II 2 cases had venous hypertension, one of them needed PTA due to central venous stenosis and the other improved gradually.

Ischemic monomelic neuropathy has occurred in a case of saphenous group and required immediate ligation of the fistula.

Table 9: comparison between the studied groups regarding steal, venous hypertension and ischemic monomelic neuropathy**:**

Variable		Group I (n=30)		Group II (n=30)		P
		No.	%	No.	%	
Steal	At 1 m	2	6.7	3	10.0	1.0 (NS)
	At 6 m	0	0.0	0	0.0	--------
	At 12 m	0	0.0	0	0.0	--------
Venous HTN	At 1 m	1	3.3	2	6.7	1.0 (NS)
	At 6 m	0	0.0	0	0.0	--------
	At 12 m	0	0.0	0	0.0	-------
Ischemic monomelic	At 1 m	1	3.3	0	0.0	1.0 (NS)
	At 6 m	0	0.0	0	0.0	----
	At 12 m	0	0.0	0	0.0	-----

Table 10: Comparison between the studied groups regarding occurrence of complications

		Group			X^2 (P)
		Group I	Group II	Total	
Complications	Count	26	19	45	4.36 (0.037, S)
	% within Group	86.7%	63.3%	75.0%	
Total	Count	30	30	60	
	% within Group	100.0%	100.0%	100.0%	

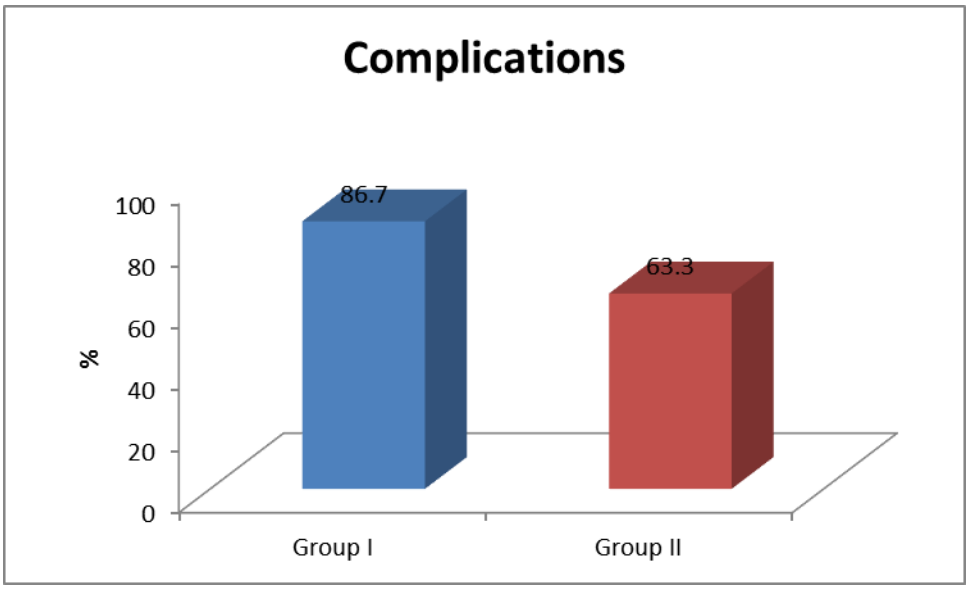


Fig (25): Bar chart showing complications in studied groups

Table 11 shows that access failure is higher in group I, it was 30%, 40% and 50% at 1, 6 and 12 months respectively in group I while it was 10%,20% and 26.7% in group II. The difference was insignificant (P value >0.05).

In group I, at 1 month 8 cases had graft thrombosis cases (26.6%) within 1-month, surgical thrombectomy was done for 7 cases and regained patency in 1 case and failed in 6 cases and 1 case refused the procedure, case of infection and

pseudoaneurysm caused removal of graft and a case of ischemic monomelic neuropathy required ligation of the fistula.

At 6 months follow up, further thrombosis in 4 cases (13.3%) (1 case associated with hematoma and pseudoaneurysm formation) in had occurred for which surgical thrombectomy was done and regained patency in 1 case only.

At 12 months follow up further thrombosis has occurred in 3 cases (10%) in which failed the trial of surgical thrombectomy. Another case of pseudoaneurysm and infection required removal of the graft. A case of venous outflow stenosis which required patch angioplasty.

On the other hand, **in group (II)**, at 1 month follow up graft thrombosis had occurred in 3 cases (10%), for which thrombectomy was done and regained patency in 1 case, a case of graft infection lead to graft removal.

At 6 months follow up ,3 cases of further thrombosis with failure of trial of thrombectomy to regain patency (1 case associated with pseudoaneurysm and infection so graft is removed) .

At 12 months follow up, another 3 cases of graft thrombosis at 12 months follow up and thrombectomy was successful in 2 of the 3 cases, a case of infection and pseudoaneurysm which required graft removal.2 cases showed venous outflow stenosis , PTA was successful to correct this stenosis.

Primary patency rate is higher in group II as it was 86.7%,76.7 and 63.3% at 1, 6 and 12 months in comparison to 66.7%, 53.3% and 40% in group I however it isn't statistically significant.

Assisted primary patency rate is also higher in group II as it was 86.7%,76.7 and 70%at 1, 6 and 12 months in group II in comparison to 66.7%, 53.3% and 40%

in group I however it isn't statistically significant in 1 and 6 months follow up but significant in 12 months follow up (P value< 0.05).

Secondary patency rate is higher in group II as it was 90%,80 and 73.3%at 1, 6 and 12 months in group II in comparison to 70%, 60% and 46.7% in group I however it isn't statistically significant in 1 and 6 months follow up but significant in 12 months follow up (P value< 0.05).

Table 11: comparison between the studied groups regarding access failure and patency rates 1ry, assisted 1ry, 2ry)

Variable		**Group I (n=30)**		**Group II (n=30)**		**X^2**	**P**
		No.	**%**	**No.**	**%**		
Access failure	**At 1 m**	9	30.0	3	10.0	**3.75**	**0.053 (NS)**
	At 6 m	12	40.0	6	20.0	**2.85**	**0.091 (NS)**
	At 12 m	15	50.0	8	26.7	**3.46**	**0.063 (NS)**
Primary patency	**At 1 m**	20	66.7	26	86.7	**3.35**	**0.067 (NS)**
	At 6 m	16	53.3	23	76.7	**3.59**	**0.058 (NS)**
	At 12 m	12	40.0	19	63.3	**3.27**	**0.071 (NS)**
Assisted primary patency	**At 1 m**	20	66.7	26	86.7	**3.35**	**0.067 (NS)**
	At 6 m	16	53.3	23	76.7	**3.59**	**0.058 (NS)**
	At 12 m	13	43.3	21	70.0	**4.34**	**0.037 (S)**
Secondary patency	**At 1 m**	21	70.0	27	90.0	**3.75**	**0.053 (NS)**
	At 6 m	18	60.0	24	80.0	**2.85**	**0.091 (NS)**
	At 12 m	14	46.7	22	73.3	**4.44**	**0.035 (S)**

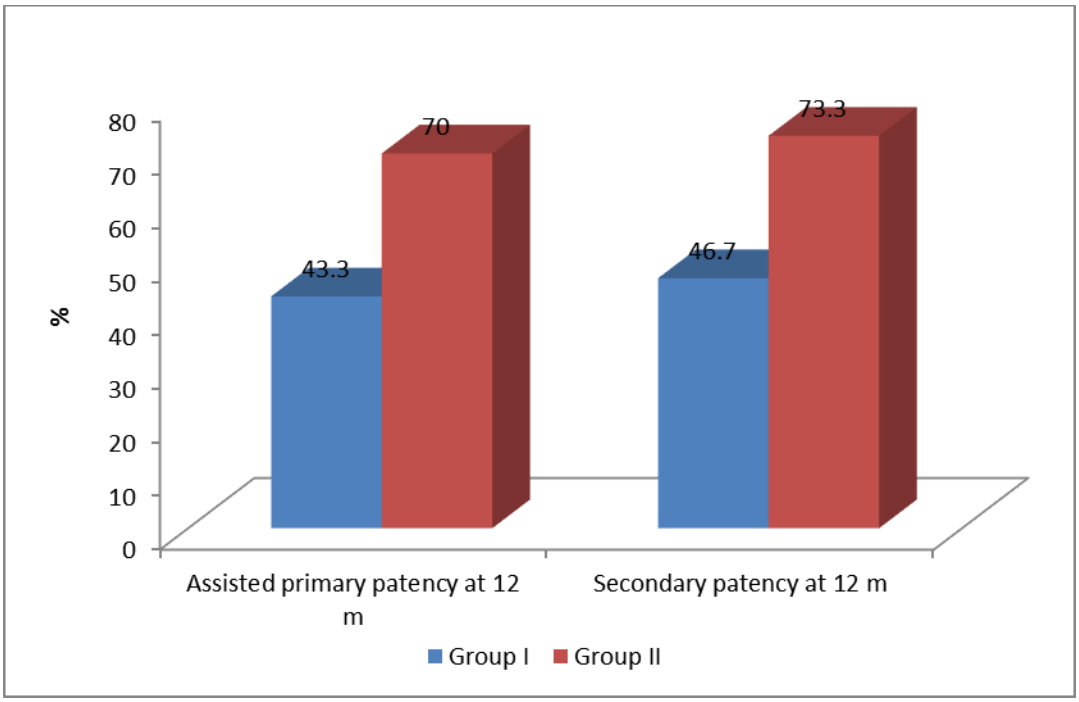


Fig (26): Bar chart showing the significant differences regarding patency among the studied groups

Patients aged younger and older than 50 years had no significant difference could be detected in patency rates in both groups with P-Value >0.05 **(table 12)**

Table 12: correlation between age of the studied patients and patency rates:

Variable		Group I (n=30)					Group II (n=30)				
		Age (years)				$P_{Chi-square}$	Age (years)				$P_{Fisher's}$
		≤50 (n=15)		>50 (n=15)			≤50 (n=10)		>50 (n=20)		
		No.	%	No.	%		No.	%	No.	%	
Primary patency	At 1 m	12	80.0	8	53.3	0.12 (NS)	8	80.0	18	90.0	**0.58 (NS)**
	At 6 m	9	60.0	7	46.7	0.46 (NS)	7	70.0	16	80.0	**0.65 (NS)**
	At 12 m	6	40.0	6	40.0	1.0 (NS)	4	40.0	15	75.0	**0.108 (NS)**

Assisted primary patency	**At 1 m**	12	80.0	8	53.3	0.12 (NS)	8	80.0	18	90.0	**0.58 (NS)**
	At 6 m	9	60.0	7	46.7	0.46 (NS)	7	70.0	16	80.0	**0.65 (NS)**
	At 12 m	7	46.7	6	40.0	0.71 (NS)	5	50.0	16	80.0	**0.11 (NS)**
Secondary patency	**At 1 m**	12	80.0	9	60.0	*0.42	9	90.0	18	90.0	**1.0 (NS)**
	At 6 m	10	66.7	8	53.3	0.45 (NS)	8	80.0	16	80.0	**1.0 (NS)**
	At 12 m	9	60.0	5	33.3	0.14 (NS)	6	60.0	16	80.0	**0.38 (NS)**

*Fisher's test was used

There was no significant difference could be detected between both genders patency rates in both groups with P-Value >0.05.

Table 13: Correlation between gender of the studied patients and patency rates**:**

Variable		**Group I (n=30)**					**Group II (n=30)**				
		Gender				**P Fisher'**	**Gender**				**P Fisher's**
		Male (n=18)		**Female (n=12)**			**Male (n=17)**		**Female (n=13)**		
		No.	**%**	**No.**	**%**		**No.**	**%**	**No.**	**%**	
Primary patency	**At 1 m**	11	61.1	9	75.0	0.69 (NS)	13	76.5	13	100.	**0.11 (NS)**
	At 6 m	9	50.0	7	58.3	†0.20 (NS)	13	76.5	10	76.9	**1.0 (NS)**
	At 12 m	8	44.4	4	33.3	0.71 (NS)	11	64.7	8	61.5	**1.0 (NS)**
Assisted primary patency	**At 1 m**	11	61.1	9	75.0	0.69 (NS)	13	76.5	13	100.	**0.11 (NS)**
	At 6 m	9	50.0	7	58.3	†0.20 (NS)	13	76.5	10	76.9	**1.0 (NS)**
	At 12 m	9	50.0	4	33.3	†0.37 (NS)	13	76.5	8	61.5	**0.11 (NS)**

Secondary patency	**At 1 m**	12	66.7	9	75.0	0.70 (NS)	14	82.4	13	100	**1.0 (NS)**
	At 6 m	11	61.1	7	58.3	1.0 (NS)	14	82.4	10	76.9	**1.0 (NS)**
	At 12 m	9	50.0	5	41.7	†0.65 (NS)	14	82.4	8	61.5	**0.24 (NS)**

†**Chi-square test was used**

Table 14 shows that no statistically significant difference in patients aged more or less than 50 years in relation to different complications in both groups

Table 14: correlation between age of the studied patients and different complications**:**

Variable		**Group I (n=30)**					**Group II (n=30)**				
		Age (years)				**$P_{Fisher's}$**	**Age (years)**				**$P_{Fisher's}$**
		≤50 (n=15)		**>50 (n=15)**			**≤50 (n=10)**		**>50 (n=20)**		
		No.	**%**	**No.**	**%**		**No.**	**%**	**No.**	**%**	
Thrombosis	**At 1 m**	3	20.0	5	33.3	0.68 (NS)	2	20.0	1	5.0	**0.25 (NS)**
	At 6 m	3	20.0	1	6,7	0.59 (NS)	1	10.0	2	10.0	**1.0 (NS)**
	At 12 m	3	20.0	0	46.7	0.22 (NS)	2	20.0	1	5.0	**0.25 (NS)**
Hematoma	**At 1 m**	2	13.3	1	6.7	1.0 (NS)	2	20.0	0	0.0	**0.103 (NS)**
	At 6 m	2	13.3	1	6.7	1.0 (NS)	1	10.0	3	15.0	**1.0 (NS)**
	At 12 m	1	6.7	1	6.7	1.0 (NS)	0	0.0	2	10.0	**0.54 (NS)**
Seroma	**At 1 m**	2	13.3	2	13.3	1.0	2	20.0	3	15.0	**1.0 (NS)**

						(NS)					
	At 6 m	0	0.0	0	0.0	-------	0	0.0	0	0.0	----
	At 12 m	0	0.0	0	0.0	------	0	0.0	0	0.0	----

†**Chi-square test was used**

Table 14: correlation between age of the studied patients and different complications (Continue):

Variable		**Group I (n=30)**					**Group II (n=30)**				
		Age (years)				**$P_{Fisher's}$**	**Age (years)**				**$P_{Fisher's}$**
		≤50 (n=15)		**>50 (n=15)**			**≤50 (n=10)**		**>50 (n=20)**		
		No.	**%**	**No.**	**%**		**No.**	**%**	**No.**	**%**	
Lymphorrhea	**At 1 m**	3	20.0	1	6.7	0.59 (NS)	1	10.0	1	5.0	**1.0 (NS)**
	At 6 m	0	0.0	0	0.0	------	0	0.0	0	0.0	----
	At 12 m	0	0.0	0	0.0	------	0	0.0	0	0.0	-----
Infection	**At 1 m**	3	20.0	1	6.7	0.59 (NS)	1	10.0	2	10.0	**1.0 (NS)**
	At 6 m	0	0.0	0	0.0	---	1	10.0	1	5.0	**1.0 (NS)**
	At 12 m	0	0.0	1	6.7	1.0 (NS)	1	10.0	0	0.0	**0.33 (NS)**
Wound dehiscence	**At 1 m**	1	6.7	2	13.3	1.0 (NS)	1	10.0	1	5.0	**1.0 (NS)**
	At 6 m	0	0.0	0	0.0	-------	0	0.0	0	0.0	-----
	At 12 m	0	0.0	0	0.0	------	0	0.0	0	0.0	-----

Table 14: correlation between age of the studied patients and different complications (Continue):

Variable		Group I (n=30)					Group II (n=30)				
		Age (years)				$P_{Fisher's}$	Age (years)				$P_{Fisher's}$
		≤50 (n=15)		>50 (n=15)			≤50 (n=10)		>50 (n=20)		
		No.	%	No.	%		No.	%	No.	%	
Aneurysm	At 1 m	0	0.0	0	0.0	------	0	0.0	0	0.0	-----
	At 6 m	1	6.7	0	0.0	1.0 (NS)	0	0.0	0	0.0	----
	At 12 m	0	0.0	0	0.0	-----	0	0.0	0	0.0	----
Pseudo-aneurysm	At 1 m	2	13.3	1	6.7	1.0 (NS)	1	10.0	0	0.0	**0.33 (NS)**
	At 6 m	1	6.7	0	0.0	1.0 (NS)	1	10.0	0	0.0	**0.33 (NS)**
	At 12 m	1	6.7	0	0.0	1.0 (NS)	1	10.0	0	0.0	**0.33 (NS)**
Steal	At 1 m	1	6.7	1	6.7	1.0 (NS)	0	0.0	3	15.0	**0.53 (NS)**
	At 6 m	0	0.0	0	0.0	-------	0	0.0	0	0.0	----
	At 12 m	0	0.0	0	0.0	------	0	0.0	0	0.0	----

Table 14: correlation between age of the studied patients and different complications (Continue):

Variable		Group I (n=30)					Group II (n=30)				
		Age (years)				$P_{Fisher's}$	Age (years)				$P_{Fisher's}$
		≤50 (n=15)		>50 (n=15)			≤50 (n=10)		>50 (n=20)		
		No.	%	No.	%		No.	%	No.	%	
Venous HTN	At 1 m	1	6.7	0	0.0	1.0 (NS)	0	0.0	2	10.0	**0.54 (NS)**
	At 6 m	0	0.0	0	0.0	-----	0	0.0	0	0.0	----

	At 12 m	0	0.0	0	0.0	-----	0	0.0	0	0.0	**----**
Ischemic neuropathy	**At 1 m**	0	0.0	1	6.7	1.0 (NS)	0	0.0	0	0.0	**----**
	At 6 m	0	0.0	0	0.0	----	0	0.0	0	0.0	**----**
	At 12 m	0	0.0	0	0.0	-----	0	0.0	0	0.0	**----**
Access failure	**At 1 m**	3	20.0	6	40.0	0.42 (NS)	1	10.0	2	10.0	**1.0 (NS)**
	At 6 m	5	33.3	7	46.7	†0.46 (NS)	2	20.0	4	20.0	**0.67 (NS)**
	At 12 m	6	40.0	9	60.0	†0.27 (NS)	4	40.0	4	20.0	**0.38 (NS)**

†**Chi-square test was used**

Table 15 shows that no statistically significant difference in both genders in relation to different complications in both groups.

Table 15: correlation between gender of the studied patients and different complications:

Variable		**Group I (n=30)**					**Group II (n=30)**				
		Gender				**$P_{Fisher's}$**	**Gender**				**$P_{Fisher's}$**
		Male (n=18)		**Female (n=12)**			**Male (n=17)**		**Female (n=13)**		
		No.	**%**	**No.**	**%**		**No.**	**%**	**No.**	**%**	
Thrombosis	**At 1 m**	6	33.3	2	16.7	0.42 (NS)	3	17.6	0	0.0	**0.42 (NS)**
	At 6 m	2	11.1	2	16.7	1.0 (NS)	0	0	3	23.1	**0.07 (NS)**
	At 12 m	0	0	3	25.0	†0.054 (NS)	1	5.9	2	15.4	**0.56 (NS)**
Hematoma	**At 1 m**	2	11.1	1	8.3	1.0 (NS)	1	5.9	1	7.7	**1.0 (NS)**
	At 6 m	3	16.7	0	0.0	0.25 (NS)	1	5.9	3	23.1	**0.29 (NS)**
	At 12 m	2	11.1	0	0.0	0.50 (NS)	1	5.9	1	7.7	**1.0 (NS)**

Seroma	**At 1 m**	3	16.7	1	8.3	0.63 (NS)	3	17.6	2	15.4	**1.0 (NS)**
	At 6 m	0	0.0	0	0.0	-------	0	0.0	0	0.0	**----**
	At 12 m	0	0.0	0	0.0	------	0	0.0	0	0.0	**----**

†**Chi-square test was used**

Table 15: correlation between gender of the studied patients and different complications(continue)

Variable		**Group I (n=30)**					**Group II (n=30)**				
		Gender				**$P_{Fisher's}$**	**Gender**				**Fisher's**
		Male (n=18)		**Female (n=12)**			**Male (n=17)**		**Female (n=13)**		
		No.	**%**	**No.**	**%**		**No.**	**%**	**No.**	**%**	
Lymphorrhea	**At 1 m**	4	22.2	0	0.0	0.13 (NS)	1	5.9	1	7.7	**1.0 (NS)**
	At 6 m	0	0.0	0	0.0	-----	0	0.0	0	0.0	**----**
	At 12 m	0	0.0	0	0.0	-----	0	0.0	0	0.0	**----**
Infection	**At 1 m**	2	11.1	2	16.7	1.0 (NS)	3	17.6	0	0.0	**0.24 (NS)**
	At 6 m	0	0.0	0	0.0	-----	0	0.0	2	15.4	**0.18 (NS)**
	At 12 m	0	0.0	1	8.3	0.50 (NS)	0	0.0	1	7.7	**0.43 (NS)**
Wound dehiscence	**At 1 m**	2	11.1	1	8.3	1.0 (NS)	1	5.9	1	7.7	**1.0 (NS)**
	At 6 m	0	0.0	0	0.0	-------	0	0.0	0	0.0	**----**
	At 12 m	0	0.0	0	0.0	------	0	0.0	0	0.0	**----**

Table 15: correlation between gender of the studied patients and different complications(continue)

Variable		Group I (n=30)					Group II (n=30)				
		Gender				$P_{Fisher's}$	Gender				$P_{Fisher's}$
		Male (n=18)		Female (n=12)			Male (n=17)		Female (n=13)		
		No.	%	No.	%		No.	%	No.	%	
Aneurysm	At 1 m	0	0.0	0	0.0	-----	0	0.0	0	0.0	----
	At 6 m	1	5.6	0	0.0	1.0 (NS)	0	0.0	0	0.0	----
	At 12 m	0	0.0	0	0.0	-----	0	0.0	0	0.0	----
Pseudo-aneurysm	At 1 m	1	5.6	2	16.7	0.55 (NS)	1	5.9	0	0.0	**1.0 (NS)**
	At 6 m	1	5.6	0	0.0	1.0 (NS)	0	0.0	1	7.7	**0.43 (NS)**
	At 12 m	0	0.0	1	8.3	0.40 (NS)	0	0.0	1	7.7	**0.43 (NS)**
Steal	At 1 m	1	5.6	1	8.3	1.0 (NS)	2	11.8	1	7.7	**1.0 (NS)**
	At 6 m	0	0.0	0	0.0	-------	0	0.0	0	0.0	----
	At 12 m	0	0.0	0	0.0	------	0	0.0	0	0.0	----

Variable		Group I (n=30)					Group II (n=30)				
		Gender				$P_{Fisher's}$	Gender				$P_{Fisher's}$
		Male (n=18)		Female (n=12)			Male (n=17)		Female (n=13)		
		No.	%	No.	%		No.	%	No.	%	
Venous HTN	At 1 m	1	5.6	0	0.0	1.0 (NS)	2	11.8	0	0.0	**0.49 (NS)**
	At 6 m	0	0.0	0	0.0	-----	0	0.0	0	0.0	----
	At 12 m	0	0.0	0	0.0	-----	0	0.0	0	0.0	----

Ischemic neuropathy	**At 1 m**	1	5.6	0	0.0	1.0 (NS)	0	0.0	0	0.0	-----
	At 6 m	0	0.0	0	0.0	-----	0	0.0	0	0.0	-----
	At 12 m	0	0.0	0	0.0	----	0	0.0	0	0.0	----
Access failure	**At 1 m**	6	33.3	3	25.0	0.7 (NS)	3	17.6	0	0.0	**0.24 (NS)**
	At 6 m	7	38.9	5	41.7	1.0 (NS)	3	17.6	3	23.1	**1.0 (NS)**
	At 12 m	8	44.4	7	58.3	0.71 (NS)	3	17.6	5	38.5	**0.24 (NS)**

Table 16 shows that no statistically significant difference in smokers and non-smokers and patients had or hadn't comorbidities in relation to different complications in both groups except in group 2 in 12 months follow up in which thrombosis is significantly higher in patients with comorbidities.

Table 16: Correlation between ((presence of comorbidities (DM, HTN, IHD) and smoking)) in the studied patients in both groups and different complications:

Variable		**Group I (n=30)**					**Group II (n=30)**				
		Co-morbidities				**$P_{Fisher's}$**	**Co-morbidities**				**$P_{Fisher's}$**
		No (n=18)		**Yes (n=12)**			**No (n=19)**		**Yes (n=11)**		
		No.	**%**	**No.**	**%**		**No.**	**%**	**No.**	**%**	
Thrombosis	**At 1 m**	3	16.7	5	41.7	0.21 (NS)	2	10.5	1	9.1	**1.0 (NS)**
	At 6 m	3	16.7	1	8.3	0.63 (NS)	3	15.8	0	0	**0.28 (NS)**
	At 12 m	2	11.1	1	8.3	1.0 (NS)	0	0	3	27.3	**0.041 (S)**
Hematoma	**At 1 m**	2	11.1	1	8.3	1.0 (NS)	2	10.5	0	0.0	**0.52 (NS)**
	At 6 m	2	11.1	1	8.3	1.0 (NS)	3	15.8	1	9.1	**1.0 (NS)**
	At 12 m	1	5.6	1	8.3	1.0	1	5.3	1	9.1	**1.0 (NS)**

						(NS)					
Seroma	**At 1 m**	2	11.1	2	16.7	1.0 (NS)	16	3	15.8	2	18.2
	At 6 m	0	0.0	0	0.0	-------	0	0.0	0	0.0	----
	At 12 m	0	0.0	0	0.0	------	0	0.0	0	0.0	----

†**Chi-square test was used**

Table 16: Correlation between ((presence of comorbidities (DM, HTN, IHD) and smoking)) in the studied patients in both groups and different complications: (continue)

Variable		**Group I (n=30)**					**Group II (n=30)**				
		Co-morbidities				**$P_{Fisher's}$**	**Co-morbidities**				**$P_{Fisher's}$**
		No (n=18)		**Yes (n=12)**			**No (n=19)**		**Yes (n=11)**		
		No.	**%**	**No.**	**%**		**No.**	**%**	**No.**	**%**	
Lymphorrhea	**At 1 m**	3	16.7	1	8.3	0.63 (NS)	0	0.0	2	18.2	**0.126 (NS)**
	At 6 m	0	0.0	0	0.0	----	0	0.0	0	0.0	----
	At 12 m	0	0.0	0	0.0	----	0	0.0	0	0.0	----
Infection	**At 1 m**	3	16.7	1	8.3	0.63 (NS)	1	5.3	2	18.2	**0.54 (NS)**
	At 6 m	0	0.0	0	0.0	-----	2	10.5	0	0.0	**0.52 (NS)**
	At 12 m	1	5.6	0	0.0	1.0 (NS)	1	5.3	0	0.0	**1.0 (NS)**
Wound dehiscence	**At 1 m**	2	11.1	1	8.3	1.0 (NS)	1	5.3	1	9.1	**1.0 (NS)**
	At 6 m	0	0.0	0	0.0	-------	0	0.0	0	0.0	----
	At 12 m	0	0.0	0	0.0	------	0	0.0	0	0.0	----

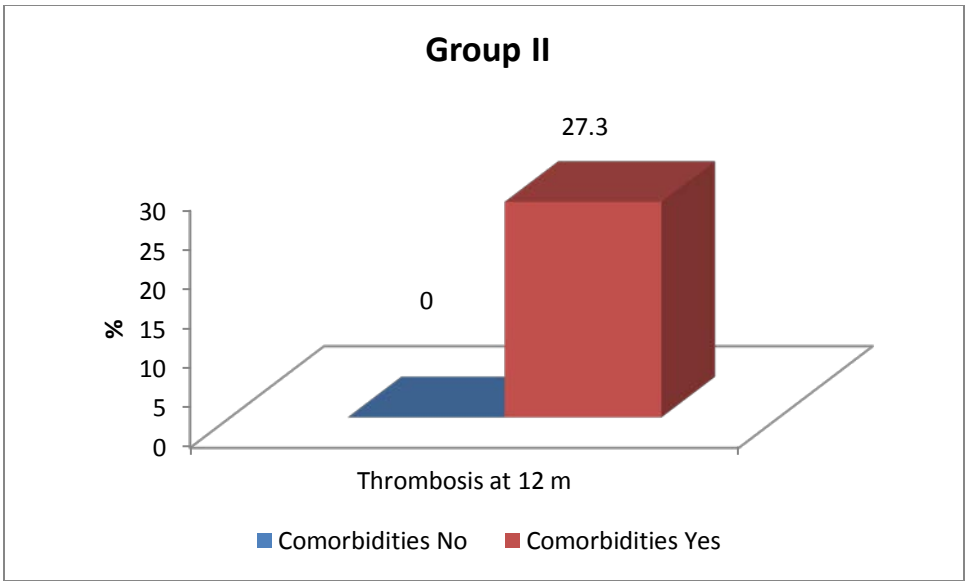


Fig (27): Bar chart showing thrombosis at 12 months with comorbidities in group II

Table 16: Correlation between ((presence of comorbidities (DM, HTN, IHD) and smoking)) in the studied patients in both groups and different complications: (continue)

Variable		Group I (n=30)					Group II (n=30)				
		Co-morbidities				$P_{Fisher's}$	Co-morbidities				$P_{Fisher's}$
		No (n=18)		Yes (n=12)			No (n=19)		Yes (n=11)		
		No.	%	No.	%		No.	%	No.	%	
Aneurysm	At 1 m	0	0.0	0	0.0	----	0	0.0	0	0.0	-----
	At 6 m	0	0.0	1	8.3	0.4 (NS)	0	0.0	0	0.0	----
	At 12 m	0	0.0	0	0.0	----	0	0.0	0	0.0	----
Pseudo-aneurysm	At 1 m	3	16.7	0	0.0	0.25 (NS)	0	0.0	1	9.1	**0.37 (NS)**
	At 6 m	1	5.6	0	0.0	1.0 (NS)	1	5.3	0	0.0	**1.0 (NS)**
	At 12 m	1	5.6	0	0.0	1.0 (NS)	1	5.3	0	0.0	**1.0 (NS)**
Steal	At 1 m	1	5.6	1	8.3	1.0 (NS)	2	10.5	1	9.1	**1.0 (NS)**

	At 6 m	0	0.0	0	0.0	-------	0	0.0	0	0.0	----
	At 12 m	0	0.0	0	0.0	------	0	0.0	0	0.0	----

Variable		**Group I (n=30)**					**Group II (n=30)**				
		Co-morbidities				**$P_{Fisher's}$**	**Co-morbidities**				**$P_{Fisher's}$**
		No (n=18)		**Yes (n=12)**			**No (n=19)**		**Yes (n=11)**		
		No.	**%**	**No.**	**%**		**No.**	**%**	**No.**	**%**	
Venous HTN	**At 1 m**	0	0.0	1	8.3	0.4 (NS)	0	0.0	2	18.2	**0.126 (NS)**
	At 6 m	0	0.0	0	0.0	----	0	0.0	0	0.0	----
	At 12 m	0	0.0	0	0.0	----	0	0.0	0	0.0	----
Ischemic neuropathy	**At 1 m**	1	5.6	0	0.0	1.0 (NS)	0	0.0	0	0.0	----
	At 6 m	0	0.0	0	0.0	----	0	0.0	0	0.0	----
	At 12 m	0	0.0	0	0.0	----	0	0.0	0	0.0	----
Access failure	**At 1 m**	5	27.8	4	33.3	1.0 (NS)	2	10.5	1	9.1	**1.0 (NS)**
	At 6 m	8	44.4	4	33.3	0.71 (NS)	5	26.3	1	9.1	**0.37 (NS)**
	At 12 m	0	0.0	0	0.0	†0.46 (NS)	6	31.6	2	18.2	**0.67 (NS)**

†**Chi-square test was used**

Prescence of comorbidities didn't have a statistically significant effect in patency rates in both groups.

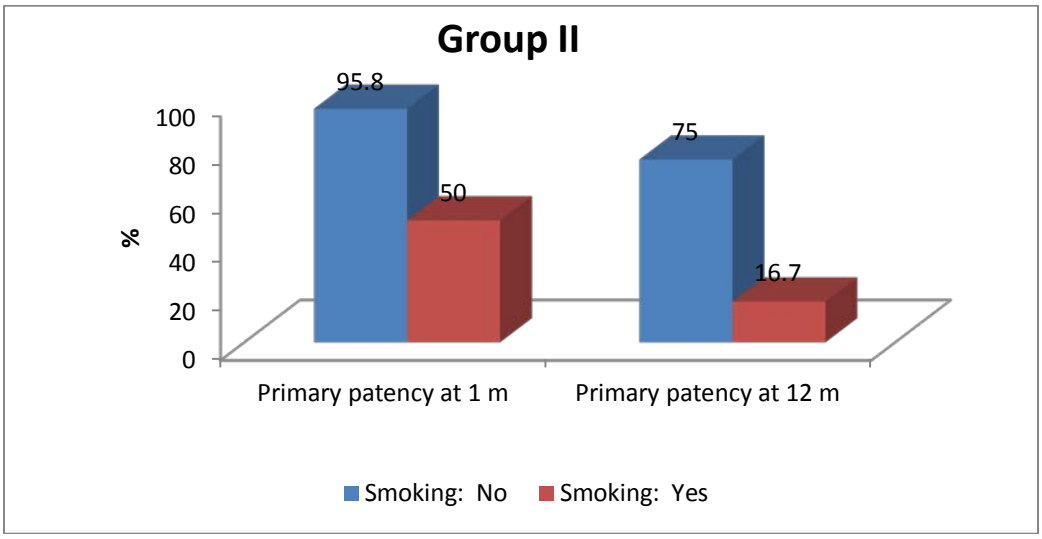
Table 17: Correlation between ((presence of comorbidities (DM, HTN, IHD) and smoking)) in the studied patients in both groups and patency rates:

Variable		Group I (n=30)					Group II (n=30)				
		Co-morbidities				P Fisher's	Co-morbidities				P Fisher's
		No (n=18)		Yes (n=12)			No (n=19)		Yes (n=11)		
		No.	%	No.	%		No.	%	No.	%	
Primary patency	At 1 m	13	72.2	7	58.3	0.46 (NS)	16	84.2	10	90.9	**1.0 (NS)**
	At 6 m	10	55.6	6	50.0	†0.76 (NS)	13	68.4	10	90.9	**0.215 (NS)**
	At 12 m	6	33.3	6	50.0	0.46 (NS)	12	63.2	7	63.6	**1.0 (NS)**
Assisted primary patency	At 1 m	13	72.2	7	58.3	0.46 (NS)	16	84.2	10	90.9	**1.0 (NS)**
	At 6 m	10	55.6	6	50.0	†0.76 (NS)	13	68.4	10	90.9	**0.215 (NS)**
	At 12 m	1	38.9	6	50.0	†0.55 (NS)	12	63.2	9	81.8	**0.42 (NS)**
Secondary patency	At 1 m	13	72.2	8	66.7	1.0 (NS)	17	89.5	10	90.9	**1.0 (NS)**
	At 6 m	10	55.6	8	66.7	0.71 (NS)	14	73.7	10	90.9	**0.37 (NS)**
	At 12 m	8	44.4	6	50.0	†0.76 (NS)	13	68.4	9	81.8	**0.67 (NS)**

Primary patency rate is significantly affected in smokers in group II as patency rate in non-smokers was 95.8 % at 1 month and 75% at 12 months while it was 50% and 16.7% in smokers at 1 and 12 months.

Table 18: correlation between smoking and patency rates.

Variable		Group I (n=30)					Group II (n=30)				
		Smoking				P Fisher's	Smoking				P Fisher's
		No (n=25)		Yes (n=5)			No (n=24)		Yes (n=6)		
		No.	%	No.	%		No.	%	No.	%	
Primary patency	At 1 m	18	72.0	2	40.0	0.3 (NS)	23	95.8	3	50.0	**0.018 (S)**
	At 6 m	14	56.0	2	40.0	0.64 (NS)	20	83.3	3	50.0	**0.12 (NS)**
	At 12 m	10	40.0	2	40.0	0.46 (NS)	18	75.0	1	16.7	**0.016 (S)**
Assisted primary patency	At 1 m	18	72.0	2	40.0	0.3 (NS)	23	95.8	3	50.0	**0.018 (S)**
	At 6 m	14	56.0	2	40.0	0.64 (NS)	20	83.3	3	50.0	**0.12 (NS)**
	At 12 m	11	44.0	2	40.0	1.0 (NS)	18	75.0	3	50.0	**0.33 (NS)**
Secondary patency	At 1 m	18	72.0	3	60.0	0.62 (NS)	23	95.8	4	66.7	**0.094 (NS)**
	At 6 m	15	60.0	3	60.0	1.0 (NS)	20	83.3	4	66.7	**0.57 (NS)**
	At 12 m	13	52.0	1	20.0	0.33 (NS)	18	75.0	4	66.7	**0.65 (NS)**



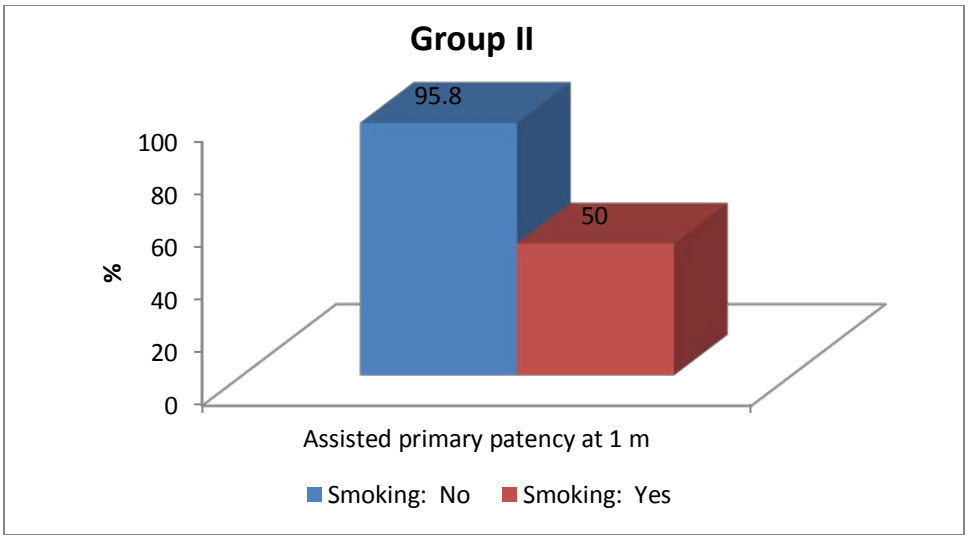


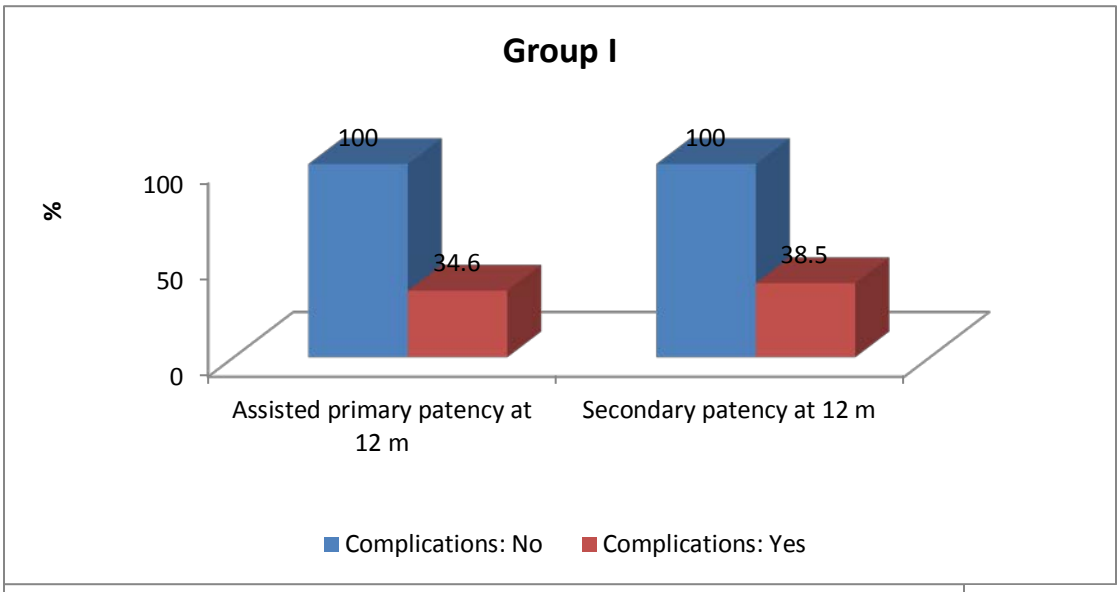
Fig (28): Bar charts showing correlation between smoking and patency rates in studied groups

Presence of complications affected patency rates in both groups but it is not statistically significant (P value >0.05) (except in assisted primary patency rates at 12 months in both groups and secondary patency in group I at 12 months follow up in which p value >0.05)

Table 19: correlation between complications and patency rates

Variable		Group I (n=30)					Group II (n=30)				
		Complications				P Fisher's	Complications				P Fisher's
		No (n=4)		Yes (n=26)			No (n=11)		Yes (n=19)		
		No.	%	No.	%		No.	%	No.	%	
Primary patency	At 1 m	4	100.0	16	61.5	0.27 (NS)	10	90.9	16	84.2	**1.0 (NS)**
	At 6 m	4	100.0	12	46.2	0.103 (NS)	10	90.9	13	68.4	**0.21 (NS)**
	At 12 m	3	75.0	9	34.6	0.27 (NS)	9	81.8	10	52.6	**0.14 (NS)**
Assisted primary patency	At 1 m	4	100.0	16	61.5	0.27 (NS)	10	90.9	16	84.2	**1.0 (NS)**
	At 6 m	4	100.0	12	46.2	0.103	10	90.9	13	68.4	**0.21 (NS)**

						(NS)					
	At 12 m	4	100.0	9	34.6	0.026 (S)	11	100.	10	52.6	**0.011 (S)**
Secondary patency	**At 1 m**	4	100.0	17	65.4	0.28 (NS)	10	90.9	17	89.5	**1.0 (NS)**
	At 6 m	4	100.0	14	53.8	0.13 (NS)	10	90.9	14	73.7	**0.37 (NS)**
	At 12 m	4	100.0	10	38.5	0.037 (S)	10	90.9	12	63.2	**0.199 (NS)**



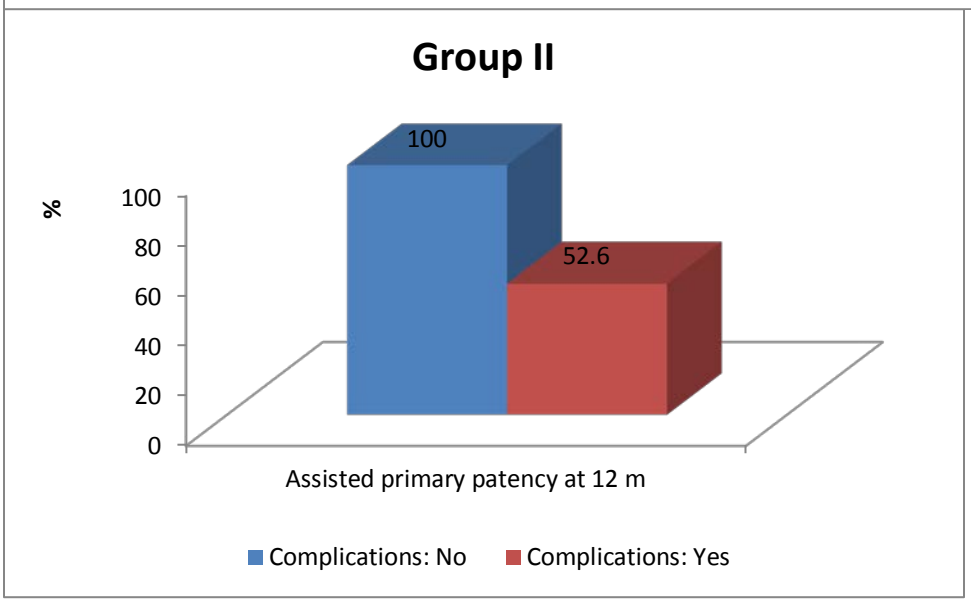


Fig (29): Bar charts showing correlation between complications and patency rates in stud

Discussion

Easy access to the vascular system is vital in patients with End Stage Renal Disease (ESRD) who need long-term hemodialysis [104]. The availability of dialysis and long-term survival of patients with ESRD has dramatically increased. Patients who require long-term hemodialysis also need long-term VA. The primary use of autologous AVF is recommended by the NKF-DOQI practice guidelines [105]. The gold standard in VA remains the native distal or proximal fistula, with or without blood vessels transposition. The main factors considered for the choice of a vascular access are the capacity to achieve a long patency time and avoidance of complications such as infections, thrombosis and pseudoaneurysm formation [106].

There are no opposition on the fact that ideal hemodialysis access should be durable, low risk of infection and minimal revision operation to maintain patency. The first and second choices for VA are radial-cephalic AVF and brachial-cephalic AVF, respectively [61].

Unfortunately, many patients are unable to have or maintain a distal upper limb AVF because of inadequate veins or arteries and therefore require more proximal access sites [107]. Bracio basilic AVF offers excellent access in difficult cases with unsuitable or exhausted forearm vessels and arm cephalic vein in either one or two stages [108].

Controversy still exists regarding the choice of the kind of VA to be performed when primary fistulas have failed, in patients with a longer duration of dialysis, or in those affected with some kind of vessel pathology that makes it difficult to set up and maintain a functional VA, including diabetic patients and older patients showing arteriosclerotic degeneration [109].

For long-term hemodialysis, patients lacking adequate superficial veins including basilic vein, the choices are generally between an autologous vein and placement of prosthetic grafts. Based on the all-autogenous policy issued by the National Kidney Foundation, it is believed that additional autologous options should be considered before placing a prosthetic graft so, saphenous vein translocation for brachioaxillary angioacces may be a suitable alternative of synthetic graft in patients with inadequate or exhausted upper limb superficial veins including basilic vein [(25)].

The idea of using the GSV as a graft between the artery and vein has been aroused in 1973 by Adar et. al using cadaveric saphenous veins, although he achieved a reasonable patency rate (as high as 70% after 1 year compared to primary patency of 80% at end of 1 year in our study), the grafts tended to develop aneurysm due to graft immunogenicity and graft degeneration [(110)] and this complication was not included in our study because we used autogenous saphenous vein.

In 1974 Haimov et al, utilized the autogenous saphenous vein graft in comparison with the bovine heterograft and found that the bovine heterograft was costly, had tendency to graft degeneration and aneurysm formation, and higher infection risk in comparison with autogenous saphenous graft [(111)] and this result about infection rate matches with the results in our study where there was only two cases of infection (2 out of 30) in the saphenous group (6.6%) because we used autogenous saphenous vein compared to 2 cases of infection (2 out of 20 cases in the autogenous group of Haimov et al study (10%)) .

Ramacciotti et al. described the results of brachioaxillary AVF with SV grafts in nine patients and compared them with results for 10 patients who received PTFE grafts. The SV grafts exhibited better patency rates and lower complication

rates and infection was only observed with PTFE grafts. Also, the authors stated that using inverted SV involves greater technical difficulty, notwithstanding the good short-term and long-term results and the absence of infection. [112] However, in our study better patency rates and lower complication rates were observed with the synthetic graft group.

Previous studies have shown that use of PTFE grafts is associated with better results in brachioaxillary AVFs than in brachiocephalic AVFs, in terms of the arteriovenous hemodynamic changes resulting from placement of such grafts [113]. One-year patency rates of PTFE grafts in brachioaxillary AVFs vary from 64% to 76% [4,7] but can decrease to 36% in radiocephalic, brachiocephalic, and brachiobasilic AVFs, especially in diabetic patients [114] matching with our study, one-year primary patency of PTFE grafts was 63.6% and secondary patency was 73.3%.

Also, in our study, the time for graft maturation was within a mean interval of 39.9± 7.71 days and 14.0± 2.04 days after the intervention for the saphenous and synthetic group respectively, it was longer than Schild et al.[115] ,study in which all patients were able to cannulate the synthetic graft within 72 hrs postoperative , but matching with other studies recommended that most polytetrafluoroethylene (PTFE) grafts mature 2-3 weeks prior to use[116]. A graft that can be successfully cannulated in early postoperative period would alleviate the need for a central venous catheter thus greatly reducing complications and cost. Indwelling central venous catheters have been shown to have dangerous complications such as central venous stenosis and very high infection rates. This can lead to septicemia, sub-acute bacterial endocarditis, brain/spinal abscesses and possibly death. Central venous occlusion will prevent future use of that extremity for any type of future access. [117]

Several demographic factors were evaluated for their effect on graft patency. Theoretically, gender (women), diabetes mellitus, and smoking should negatively impact graft patency on account of small-caliber vessels and distal vascular disease [(118)]. There was no significant difference in our study could be detected between both genders patency rates in both groups with P-Value >0.05. Also, Presence of comorbidities (diabetes, hypertension, ischemic heart disease) didn't have a statistically significant effect in patency rates in both groups and this match with Cinat et al. study in which did not show any significant difference in patency in these patient populations [(118)]. In schild et al. The failure rate for men was 27.2% (56 of 206) and and for women was 41.2% (35 of 85). This follows from the fact that female vessels are generally smaller and, therefore, less amendable to AVF construction [(119)]. In the same study, other risk factors, including HIV+ status, hypertension, and diabetes, demonstrated minimal failure differences (33%, 31%, and 36%, respectively). [(119)]

Primary patency rate is significantly affected in smokers in group II as patency rate in non-smokers was 95.8 % at 1 month and 75% at 12 months while it was 50% and 16.7% in smokers at 1 and 12 months. This matches with Monroy-Cuadros et al. study in which smokers were 3.7 times more likely to experience primary functional patency failure [(120)]. The direct link to AVF failure was first described by Wetzig et al, [(121)] who reported a significantly higher incidence of early and late fistula failure in patients who were cigarette smokers, findings that have since been confirmed by other studies [(120,122)].

Patients aged younger and older than 50 years, in our study had no significant difference could be detected in patency rates in both groups with P-Value >0.05.In Cinat et al. study ,older patients (>60 years of age) had a statistically significant increase in primary patency rate at 1 year compared with younger patients (60 years or less), with graft survival of 56% versus 29% ($p < 0.05$)[(118)]and this finding

supports data reported in a large retrospective review by Kennedy et al. where elderly patients also had improved graft patency. The mechanism for this is unclear. Perhaps younger patients with early onset renal failure have more aggressive vascular and systemic disease predisposing them to early graft thrombosis and decreased graft patency [(123)].

Mean total operation time in our study was 120.7± 9.51 minutes and 91.0±2.04 minutes for the saphenous and synthetic group respectively that showed significant statistical difference (p value <0.001) and this matches with Oto et al. study in which the total operating time of the SV group was significantly longer than that of the PTFE group (108.2 ± 7.3 vs 73.1 ± 3.1 min, p < 0.0001) [(124)].

Schneider et al. described 309 cases of AVF created using a variety of different donor arteries and receptor veins in upper limbs with conserved SV grafts, showing that primary and secondary patency rates were similar to those reported in the literature on prosthetic grafts [(125)]. In a group of 70 patients whose AVF involved different sites in upper limbs and employed conserved SV or prosthetic grafts (Gore-Tex), Mousavi et al. observed no differences in functional criteria, patency rates, or occurrence of thrombosis but they did report a significantly higher frequency of infection in patients treated with prosthetic grafts[(126)] which match with our study as 3 grafts (10%) has been infected , but in our study , there is a difference between both groups in terms of patency and graft thrombosis .

In our study, primary, assisted primary and secondary patency is higher in synthetic group than saphenous group. Primary patency rates were 86.7%,76.7% and 63.3% at 1, 6 and 12 months in synthetic group compared to 66.7%,53.3% and 40% in saphenous group. Assisted primary patency rate is also higher in synthetic group as it was 86.7%,76.7 and 70%at 1, 6 and 12 months in synthetic group in comparison to 66.7%, 53.3% and 40% in saphenous group. Secondary patency rate

is higher in synthetic group as it was 90%,80 and 73.3%at 1, 6 and 12 months in synthetic group in comparison to 70%, 60% and 46.7% in saphenous group.In contrast Uzun et al.[126]study has showed that saphenous vein interposition (SVI) group fistula failure was observed in 5 of 29 patients (17.2%). Primary patency rate was 93% in 12th month and 82% in 24th month. In PTFE group, arteriovenous fistula failure was observed in 13 of the 25 patients (52%). Primary patency rate was 88% in 12th month and 56% in 24th month. According to the Kaplan-Meier method, mean time of primary patency was significantly higher in SVI group when compared to PTFE group. [127]

On the other hand, Bosman et al., [128] study had showed that Primary patency was not statistically different in the two groups. Cumulative patency at 6, 12 and 18 months was 51%, 30% and 22%, respectively, for SV and 52%, 40% and 28%, respectively, for PTFE. Primary assisted and secondary patency was also similar. At 6, 12 and 18 months primary assisted patency was 65%, 40% and 32%, respectively, for SV, 57%, 45% and 34%, respectively, for PTFE. Secondary patency was 80%, 63% and 54%, respectively, for SV, 71%, 63% and 63%, respectively, for PTFE.

In our study, in group (I) graft thrombosis in group (1) occurred in 8 cases (26.6%) within 1-month, further thrombosis in 4 cases (13.3%) in 6 months follow up ,at 12 months follow up further thrombosis has occurred in 3 cases (10%) with total 15 cases(50%) of graft thrombosis in 1 year follow up.In group (II) graft thrombosis had occurred in 3 cases (10%) within 1 month , ,3 cases of further thrombosis within 6 months and another 3 cases at 12 months follow up with a total 9 cases (30%).SV graft thrombosis matches with Bosman et al. [128] study in which SV graft thrombosis has occurred in 56% in one year , but PTFE graft

thrombosis in our study is less as thrombosis has occurred in Bosman et al, study in 53%.

It is true that there are few researches with analytical results saying there is no difference in patency between autogenous arteriovenous fistula and prosthetic arteriovenous graft [(129)].In a retrospective study by Thomas et al, published in 2003, highlighted that the primary patency rate for the PTFE-AV brachioaxillary graft which was 58% and 33% at 6 and 12 months respectively[(130)] .The primary patency rates in our study was higher (76.6% and 63.3%) for synthetic group at both 6 and 12 months .

It is well known that infection is significantly less frequent (2%-3%) in AVFs created using autologous veins, while PTFE grafts are associated with complication rates of 11% to 35% in hemodialysis AVFs [(131)]. In our study the rate of graft infection in the synthetic group was 10% (3 out of 30 cases) and this rate matches with the rate of infection in the prosthetic graft in many studies that ranges from 10% to 20%[(132,133)] ,while graft infection in saphenous group was 6.66%(2 out of 30 cases). Bonnaud et al. reported a 12% serious infection rate with PTFE grafts compared to a 2% rate with SV grafts [(134)]. It is worth noting that arteriovenous graft infections can result from several risk factors. In hemodialysis patients, an immunological state involving impaired neutrophils, renal dysfunction with uremia and continued use of the AVF, providing potential access for bacteria, are all important risk factors for graft infection. Obesity, diabetes, hyperalbuminemia, and inadequate personal hygiene are also risk factors for infection. [(135)]

Steal is observed in our study in 2 cases of group 1, a case of grade 1 steal which didn't required any intervention and the other case was grade 2 and required banding of the fistula. In group II 3 cases(10)% of steal syndrome has occurred postoperatively 2 of them was grade 1 and needed just observation and the other

case was grade 3 when the patient had rest pain and DRIL procedure was done to him to save his limb.That matches with Lioupis et al, study in which steal occurred in PTFE group in 8.9% but with no reported interventions. [136]

In our study our decision to use saphenous vein as a graft between brachial artery and axillary vein for angioaccess was based on many factors such as the clear observation that autogenous AVF had much less complications than after synthetic graft [137], the fact that many of the Egyptian patients live in countryside (usually causing relative high risk of infection), limited supply of PTFE (because of its relative high cost) and bad reputation of the lower limbs as a site of graft for hemodialysis due to high risk of infection and ischemia and risk on life of both the limb and even life.

From the point of view that the policy of the National Kidney Foundation recommends the use of autogenous AVF before placing a synthetic graft, there is another option other than saphenous vein translocation before placing a synthetic graft which is superficial femoral vein translocation. Huber et.al did an interesting study on 30 chronic renal failure patients with limited access options and he used the superficial femoral vein as an autogenous graft for patient of limited access options and achieved a primary patency rate of 79% and 67% at 6 and 18 months respectively. this is also quite high in terms of patency favorizing autogenous grafts [138], yet, we preferred saphenous vein as a conduit because it is easier in dissection (being more superficial with no need to cut deep fascia), no interruption to the deep venous system, minimal complications in the thigh, shorter time of harvesting, availability of longer length with no fear to take popliteal vein.

Summary

End Stage Renal Disease (ESRD) is a significant public health problem. During the last few decades, there is increasing prevalence of patients requiring hemodialysis [(102)].

The primary use of autogenous arteriovenous access for chronic hemodialysis is recommended by NKF-DOQI guidelines. The Brescia-Cimino wrist (radio cephalic) fistula remains the first option of choice for access [(20)]. When distal peripheral vessels are too tiny and not suitable for creation of radio cephalic fistula, brachio cephalic and brachio basilic fistulae are indicated [(85)].

When autogenous arteriovenous fistula creation is impossible or the fistula has failed, one may decide to implant grafts as a vascular access conduit. These grafts may be autogenous such as great saphenous vein translocation or homologous vein implants [(139)] or synthetic such as PTFE (Gortex) material but Prosthetic grafts have inferior primary and secondary patency rates and higher incidence of some complications such as infections and stenosis formation (mostly at the graft vein anastomosis) leading to thrombotic occlusion within 12 to 24 months compared with autogenous fistulae [(122)]

This study was conducted in the period from March 2018 to February 2020 , prospective randomized controlled study included 60 patients with a clinical diagnosis of end-stage renal failure (ESRF) requiring hemodialysis. Thirty patients were operated upon by saphenous graft for brachio-axillary shunt while the other thirty patients were operated upon by synthetic graft (PTFE) for brachio-axillary shunt.

A) Saphenous group:

Great Saphenous Vein (GSV) was translocated from the thigh under spinal anesthesia and implanted in the arm in a lateral subcutaneous tunnel under regional anesthesia. The fistula was used for hemodialysis after a minimum period of 4 weeks (after maturation of the vein).

B) Synthetic group:

Synthetic graft PTFE was implanted in the arm in a lateral subcutaneous tunnel between brachial artery and axillary vein under local anesthesia.The graft was used for dialysis after a minimum period of 10 days. The patients were followed up for a period of 1 year to assess the patency of AVF and the presence of complications such as infection, stenosis, aneurysm formation, thrombosis, venous hypertension and steal syndrome.

In our study, group I (saphenous) included 30 patients and group II (synthetic) included 30 patients. The difference in age, sex and associated diseases between 2 groups was not statistically significant. Mean total operation time for saphenous group was significantly longer than that for synthetic group (p value <0.001). The first needle puncture for hemodialysis in saphenous group was significantly longer than that in synthetic group (p value <0.001). During the follow up period, Patency rates was higher in the synthetic group compared to saphenous group.

As regards complications, vascular thrombosis was significantly higher in the saphenous group compared to synthetic group while graft infection was higher in synthetic group.

In our study our decision to use saphenous vein as a graft between brachial artery and axillary vein for angioaccess was based on many factors such as the clear observation that autogenous AVF had much less complications than after

synthetic graft [137], the fact that many of the Egyptian patients live in countryside (usually causing relative high risk of infection), limited supply of PTFE (because of its relative high cost) and bad reputation of the lower limbs as a site of graft for hemodialysis due to high risk of infection and ischemia and risk on life of both the limb and even life.

Conclusion

The optimal solution for hemodialysis patients with bilateral exhausted or unsuitable upper limb superficial veins including basilic vein in Egypt remains undefined due to relative high cost of expanded poly-tetra-fluoro-ethylene (PTFE) and high susceptibility to infection due to aseptic conditions during haemodialysis and bad patient hygiene. Brachio-Axillary translocated great saphenous vein could be an attractive idea as an alternative to synthetic graft but with lower patency rate and higher rate of postoperative morbidity and re-intervention, so it should be reserved as the last resort in upper limb hemodialysis access before using lower limb, central venous access or peritoneal dialysis.

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الملخص العربي

يعتمد عدد متزايد من المرضي في هذه الأيام علي الغسيل الكلوي الدموي و تعد المحافظة علي مدخل وعائي أمرا اساسيا للغسيل الكلوي الدموي . و يعد الناسور لشرياني الوريدي الذاتي مثالي لأنه يكون طريق أمن للغسيل الكلوي و يوفر تدفق للدم مناسب للغسيل الكلوي و ايضا يسبب معدل أقل للمضاعفات و الوفيات بالاضافة الي قلة التكلفة المادية .

تعتبر النواسير الشريانية الوريدية بين الشريان الكعبري و الوريد الرأسي الخيار الأول لوصلات الغسيل الكلوي في الطرف العلوي و ذلك لسهولة انشائها و قلة مضاعفاتها أما النواسير بين الشريان العضدي و الوريد الرأسي أو النواسير الشريانية الوريدية الذاتية الأخري تعد خيار ثانوي جيد .

و علي الرغم من ذلك ، فان الأوردة الذاتية لا تكون مناسبة في عديد المرضي لأسباب متعددة مثل تشوهات تشريحية بالأوردة و الشرايين أو فشل نواسيرتحويل سابقة أو عمليات تنكسية نتيجة أمراض مصاحبة أو نتيجة ثقب كثيف للأوردة أو عمليات تصلب أوعية مرتبطة بتقدم السن أو بمرض السكري.

و تعد القساطر الوريدية المركزية طرق بديلة في حالة استحالة عمل النواسير الشريانية الوريدية الذاتية وعلي الرغم من تكلفتها المادية العالية فانها تتسبب في مضاعفات كثيرة تؤدي الي زيادة فترات حجز المريض في المستشفي .

و لذلك تبرز بدائل أخري مثل استخدام الوصلات البيولوجية أو الصناعية و تعد أبرز المواقع التي يتم فيها استخدام هذه الوصلات استخدامها بين الشريان العضدي و الوريد الابطي . أما استخدامها في منطقة الفخذ لعمل وصلة بين الشريان الفخذي و الوريد الصافن فيعد خطيرا لأن العدوي كثيفة في هذا المكان التي لو حدثت قد تؤثر علي سلامة الطرف و المريض .

و تعد وصلات الوريد الصافن و وصلات البوليتترافلوروايثيلين الصناعية خيارات جيدة و تعطي نتائج جيدة علي المدي القصير من حيث التدفق و لكن يصاحبها بعض المضاعفات مثل حدوث عدوي أو تجلط أو تمدد في الجدار الوعائي أو تورم مصلي أو اقفار مما يؤدي الي زيادة التكلفة و المرضية علي المرضي.

و قد يمكن اعتبار الوصلات عن طريق الوريد الصافن الكبير خيارا أول في حالات استنفاذ أو عدم مناسبة الأوردة بالطرف العلوي خاصة في الدول النامية مع نقص توافر وصلات البوليتترافلوروايثيلين لأسباب اقتصادية و ازدياد معدلات العدوي .

الهدف من الدراسة :

الهدف من هذه الدراسة هو إجرء مقارنة بين استخدام الوريد الصافن العظيم و البوليتترافلوروايثيلين كوصلة بين الشريان العضدي و الوريد الابطي كوسيلة للغسيل الكلوي و دراسة نتائج الطريقتين لمعرفة الطريقة الانسب لمرضي الفشل الكلوي المزمن .

المرضي و طرق العلاج:

وقد تمت هذه الدراسه على ستين مريضا يعانون من مرض الفشل الكلوى المزمن تحت الاستصفاء الدموى المستمر ويحتاجون الى اجراء عمليه وصله شريانيه وريديه وليس لديهم اوردة طرفيه مناسبه لاجراء عملية الوصلة الشريانية الوريدية او تم استخدامها سابقا ولديهم اوردة مركزية مفتوحة

وقد قام كل المرضى باجراء الفحوصات التالية: الفحص الشامل والفحص الموضعى للطرفين العلوى والسفلى و دوبلكس ملون على الاوردة الطرفية و المركزية والشريان العضدى والوريد الصافن

تم تقسيم المرضى عشوائيا الى مجموعتين:

-المجموعة الاولي : مجموعة الوريد الصافن

تم نقل الوريد الصافى من الطرف السفلى تحت تاثير مخدر نصفى وتم زراعته فى الطرف

العلوى بين الشريان العضدى والوريد الابطى تحت تاثير مخدر موضعى

-المجموعة الثانية:مجموعة الوصلة الصناعية

تم زرع الوصلة الصناعية فى الطرف العلوى بين الشريان العضدى والوريد الابطى تحت تاثير مخدر موضعى

وتم المقارنة بين الوريد الصافن والوصلة الصناعية على مدار عام من حيث

- معدل الفشل الاولى و الثانوي

-حدوث انسداد بالوصلة و توقيته

-حدوث التهابات و عدوى بالوصلة

- حدوث ارتفاع فى الضغط الوريدى للطرف العلوى

وقد اشتملت مجموعة الوريد الصافن على ثلاثين مريضا ومجموعة الوصلة الصناعية على ثلاثين مريضا ولم يكن للاختلاف فى العمر والجنس والامراض المصاحبة بين المجموعتين قيمة إحصائية فى حين أن متوسط وقت العملية فى مجموعة الوريد الصافى كان أطول من نظيره فى مجموعة الوصلة الصناعية وكان لهذا الاختلاف قيمة إحصائية وكان توقيت استخدام الوصلة للغسيل الكلوى أطول بالنسبة لمجموعة الوريد الصافى (حوالى ستة أسابيع) مقارنة بمجموعة الوصلة الصناعية (حوالى أسبوعين) وكان لهذا الاختلاف قيمة إحصائية بالاضافة الي ان نسبة المضاعفات و التجلط كانت اعلي في المجموعة الاولي بالمقارمة بالمجموعة الثانية .

و قد خلصت الرسالة ان استخدام الوريد الصافن كوصلة بين الشريان العضدى و الوريد الابطي علي الرغم من كثرة مضاعفاته الا انه قد يكون حل اخير كوصلة للغسيل الكلوي بالطرف العلوي قبل اللجوء لحلول اخري