"A PROSPECTIVE STUDY OF OUTCOME OF ARTERIOVENOUS FISTULA BY PRIOR ASSESSMENT OF VASCULAR DIMENSIONS"

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ENDORSEMENT

This is to certify that the dissertation entitled **"A PROSPECTIVE STUDY OF OUTCOME OF ARTERIOVENOUS FISTULA BY PRIOR ASSESSMENT OF VASCULAR DIMENSIONS"** is a bonafide research work done by **CHETANA B KHAVATKOPP (REG NO. BG0114002).**

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LIST OF ABBRIVATIONS

AA	Axillary Artery
ACV	Antecubital Vein
AV	Axillary vein
AVF	Arteriovenous fistula
AVG	Arteriovenous graft
BA	Brachial Artery
BV	Basilic vein
CAPD	Continuous ambulatory peritoneal dialysis
CKD	Chronic kidney disease
CVC	Central venous catheter
CV	Cephalic vein
ESRD	End-stage renal disease
GFR	Glomerular filtration rate
HD	Haemodialysis
MRV	Magnetic Resonance Venography
NHANES III	National Health and Nutrition Examination Survey

NKF-DOQI	National Kidney Foundation Dialysis Outcomes Quality Initiative
NKF-K/DOQI	National Kidney Foundation Kidney Disease Outcomes Quality Initiative
PE	Physical examination PO - Preoperative
PSV	Peak systolic velocity
PTFE	polytetrafluoroethylene
RA	Radial artery
RRT	Renal replacement therapy
US	Ultrasound
VA	Vascular access

ABSTRACT

Purpose: The population of patients with ESRD is increasing. Hemodialysis is the major mode of renal replacement therapy. Arterio-venous fistulae (AVF) are the preferred access for HD. Of the three types of hemodialysis vascular access, arteriovenous fistulae (AVF) have higher patency rates, lower infection rates, and lower overall costs[1] than either grafts or catheters. The number of potential VA sites for HD per subject is limited. Therefore, measures to improve the longevity of VA are needed. AVF failures have been attributed to inadequate vessels used for surgery. Preoperative evaluation with Doppler ultrasonography (USG) is an excellent choice and may facilitate selection of suitable vessels and reduces AVF failures.

Objective of the study: 1) To assess the efficacy of vascular sonographic mapping before haemodialysis access placement.

2) To correlate pre-operative sonographic vascular mapping with operative findings (determined by anatomy, vessel size, patency and wall morphology) and subsequent surgical outcomes.

Materials & Methods: Patients of end stage renal disease posted for haemodialysis access in department of general medicine and nephrology at KLE'S Dr. Prabhakar Kore Hospital and Medical Research Centre, Nehrunagar, Belgaum, between January 2015 to December 2015.

Results: Majority of patients were between the age group of 61-70 years (40%). Among 50 cases of CKD, 70% cases were secondary to DM, followed by hypertension (16%),Ischemic heart disease(8%), other diseases (6%). Majority of

patients underwent radio cephalic fistula placement (54%) followed by brachiobasilar (18%), followed by braciocephalic (10%) and surgery was considered in opposite hand (right) in 18% of cases.Among diabetic patients 45% underwent radiocephalic fistula,25% underwent brachiobasilar. Correlation was done between preoperative findings by ultrasound Doppler and intraoperative findings by micrometer calliper. Significant correlation was found with radial artery(0.0058),cephalic vein(0.0001),brachial artery(0.0317),but no significant correlation was found with basilar vein.patients were followed on third postoperative day and at 3 months which showed patency of 100% and 88%.

Conclusion: Preoperative sonographic vascular mapping prior to haemodialysis access placement helps to facilitate definite selection of potential sites. The sonographic vascular mapping also helps in maximising the placement of native AVFs by reducing incidence of negative surgical exploration and increasing patency rates.

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INTRODUCTION

The population of patients with ESRD is increasing. Hemodialysis is the major mode of renal replacement therapy.[1] Hemodialysis (HD) is one of the discoveries of last century, which revolutionized the management of patients with renal failure. The vascular access (VA) is the end-stage renal disease (ESRD) patient's 'life line', providing the route for HD therapy. Arterio-venous fistulae (AVF) are the preferred access for HD. Of the three types of hemodialysis vascular access, arteriovenous fistulae (AVF) have higher patency rates,[2] lower infection rates,[3] and lower overall costs[1] than either grafts or catheters.

The National Kidney Foundation-Kidney Diseases Outcomes Quality Initiative (KDOQI) for vascular access guidelines state that patients with late-stage chronic kidney disease (CKD) should undergo native arteriovenous fistula (AVF) creation at least 6 months before anticipated start of hemodialysis (HD) treatments to obviate the need for other vascular access types, such as grafts or central catheters.

The number of potential VA sites for HD per subject is limited. Therefore, measures to improve the longevity of VA are needed. AVF failures have been attributed to inappropriate vessels used for surgery. Preoperative evaluation with Doppler ultrasonography (USG) is an excellent choice and may facilitate selection of suitable vessels and reduces AVF failures.[15]

Vascular access procedures and subsequent complications represent a major cause of morbidity, hospitalization, and expenditure for hemodialysis patients[18]. Native arteriovenous fistulas (AVFs) are preferable to synthetic arteriovenous grafts

because they are associated with a lower frequency of thrombosis and infection, as well as greater longevity [24].

Various problems are related to vascular access in patients on hemodialysis. These vascular access complications are similar to those seen in any patient with a vascular surgical procedure (eg, bleeding, vessel [graft] thrombosis)[32]. The native peripheral vascular system is also affected with higher rates of amputation and revascularization procedures.

A significant number of dialysis patients also run out of vessel site for access. Therefore, measures to improve the longevity of vascular access are needed. AVF failures have been attributed to inappropriate vessels used for surgery. Pre-operative evaluation with Doppler ultrasound may facilitate better selection of suitable vessels and reduce AVF failures.

AVFs that are never usable and early graft failures are associated with the common problem of inadequate vessel (artery or vein) selection. The surgeon's preoperative physical examination is the primary basis for AVF versus graft selection[50]. Only palpable veins are considered for construction of AVFs, and the more proximal draining venous anatomy is not known prior to the operation.

With the advent of high-resolution ultrasound (USG) scanners, the increased anatomical knowledge obtained may change surgical management with an increase in the number of AVFs versus graft placed. Ultrasonography is an excellent modality for hemodialysis access evaluation as it is efficient, readily available, non invasive and inexpensive. With US, vessels can be assessed for size, stenosis, and thrombosis. It is especially valuable in bulky individuals, diabetics, elderly and patients with history of

prior access in whom veins are poorly visualized .The work of Silva et al[35] suggests that ultrasonographic (US) preoperative data on nonpalpable and proximal veins, as well as on arterial inflow, improve the rate of appropriate AVF or graft selection. Hence most functional vessels are selected with subsequent decrease in negative surgical exploration.

However, there is limited data regarding efficacy of vascular sonographic mapping before haemodialysis access placement and subsequent surgical outcomes. Hence the present study was undertaken to assess the efficacy of vascular sonographic mapping before haemodialysis access placement and to correlate pre-operative sonographic vascular mapping with operative findings (determined by anatomy, vessel size, patency and wall morphology) and subsequent surgical outcomes.

OBJECTIVES

The objectives of this study were;

- To assess the efficacy of vascular sonographic mapping before haemodialysis access placement.

- To correlate pre-operative sonographic vascular mapping with operative findings (determined by anatomy, vessel size, patency and wall morphology) and subsequent surgical outcomes.

REVIEW OF LITERATURE

Historical note

On November 15, 1950, Ada DeBold, and her husband Harry, called the first meeting of the Committee for Nephrosis Research in a desperate attempt to save their child. Several months earlier, the couple's infant son was stricken with nephrosis, a little-known condition that had no real treatment. DeBold was determined to take positive action as she confronted the challenge of parenting a child with an incurable disease and due to her fortitude, the National Nephrosis Foundation (NNF) was born[1-2]. The NNF was the inaugural lay group that ultimately became the National Kidney Foundation in 1964.

The DeBolds' son died at age four while nephrosis was still a death sentence but his mother's efforts to connect patients and doctors paid off just a few years later when a treatment was discovered that has since saved the lives of thousands. Throughout the 1960s, the Foundation's main focus was supporting kidney patients and their families[3]. Ada DeBold continued her crusade to help those with all types of kidney disease by raising funds for research and patient services. The Foundation was quickly gaining national recognition as an important national health agency.

DIALYSIS:

HISTORICAL MILESTONES:

1861 -The foundation of the science of dialysis—the knowledge on which it is based—was laid by the Scottish scientist Thomas Graham, who coined the term dialysis 2**.**

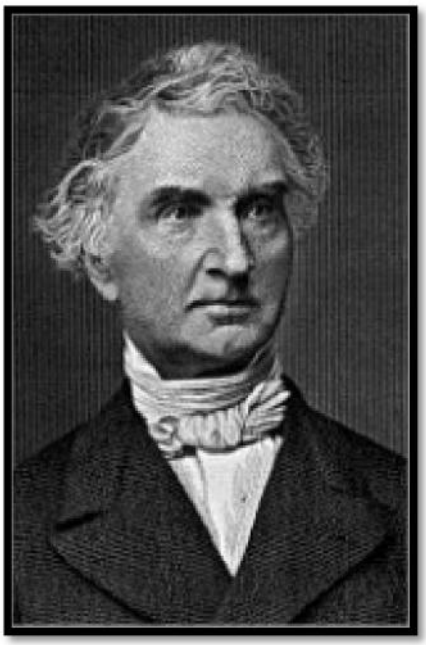


Figure 1 Thomas Graham- "Father of Dialysis"

Figure 2 - **Georg Haas (Giessen, Germany)** performed the first haemodialysis

1960 -The idea of Alwall was later taken up by Quinton, Dillard and Scribner (Seattle,USA) who developed an arteriovenous Teflon shunt. Hence Scribner shunt (Seattle) was developed

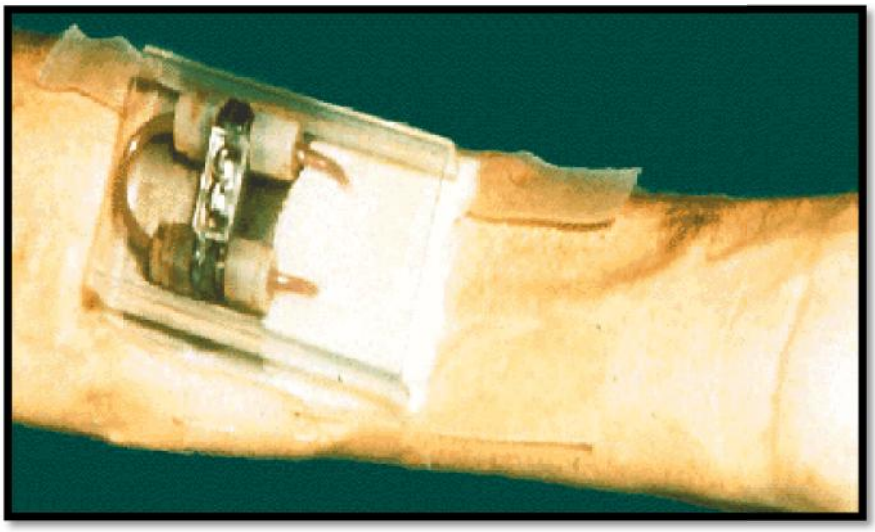


Figure 3: Quinton, Dillard and Scribner's vascular access

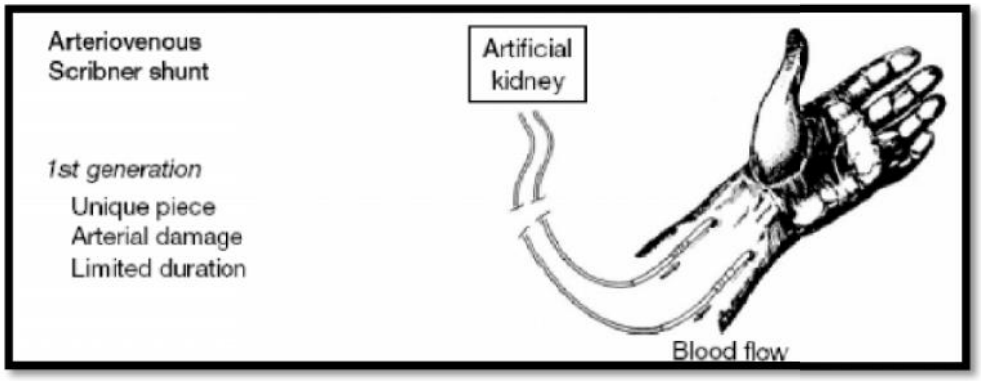


Figure 4: First Generation A-V Fistula

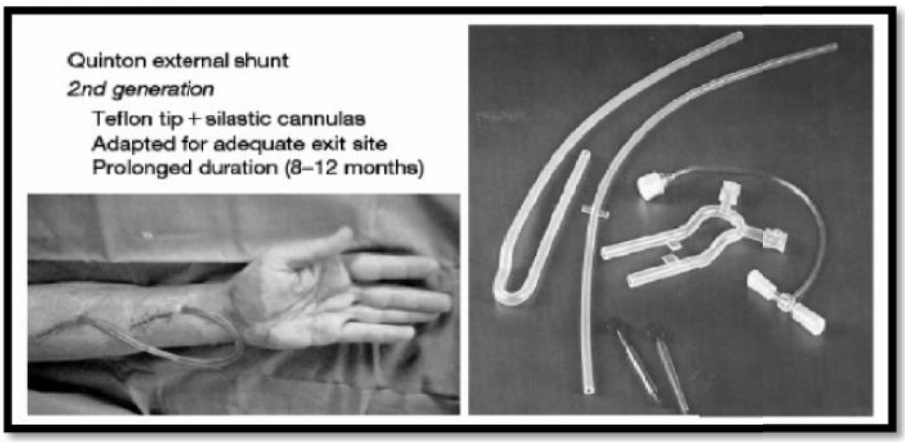


Figure 5: Second Generation Av Fistula

1966- Brescia et al.[7] proposed the possibility of surgically creating an internal arteriovenous fistula on the forearm. The legendary paper 'Chronic hemodialysis using venipuncture and a surgically created arteriovenousfistula' was published by Brescia, Cimino, Appell and Hurwich7.The first surgically created fistula for the purpose of haemodialysis was placed on 19 February 1965[4]

CHRONIC KIDNEY DISEASE (CKD):

Chronic kidney disease (CKD) is a worldwide public health problem. It is recognized as a common condition that is associated with an increased risk of cardiovascular disease[22].The Kidney Disease Outcomes Quality Initiative (KDOQI) of the National Kidney Foundation (NKF) defines chronic kidney disease as either kidney damage or a decreased glomerular filtration rate (GFR) of less than 60 mL/min/1.73 m^2 for 3 or more months. Irrespective of the underlying etiology, the destruction of renal mass with irreversible sclerosis and loss of nephrons leads to a progressive decline in GFR.[25]

Epidemiology

Prevalence

Worldwide:

The increased prevalence of chronic kidney disease (CKD) progressing to end-stage renal disease (ESRD) and the consequent financial burden of renal replacement therapy (RRT)[30,31] in both developed as well as developing nations has highlighted the importance of CKD and its risk factors.

The average incidence of ESRD in developing countries is 150 per million population (pmp), which is lower than what is reported in the developed world. This has been attributed to racial and ethnic diversity and lack of education and non

availability of medical facility which is also reflected in the disparity in the incidence of ESRD between different populations within the developed nations.[32]

Chronic Kidney Disease is the ninth leading cause of death in the United States. The Third National Health and Examination Survey (NHANES III) estimated that the prevalence of chronic kidney disease in adults is 11% (19.2 million): 3.3% (5.9 million) had stage 1, 3% (5.3 million) had stage 2, 4.3% (7.6 million) had stage 3, 0.2% (400,000) had stage 4, and 0.2% (300,000) had stage 5.[23]

The prevalence of chronic kidney disease stages 1-4 increased from 10% in 1988-1994 to 13.1% in 1999-2004. This increase is partially explained by the increase in the prevalence of diabetes and hypertension, the two most common causes of chronic kidney disease.

Indian scenario

According to the second annual report of the CKD Registry of India by the Indian Society of Nephrology, a total of 25,714 patients are included in the registry. Overall Mean age of the patients was 48.3 ± 16.6 years and constituted 68.9% Males and 31.1% Females. Among the elderly, 68.9% were reported to be males. Among the 30.3% patients diabetic nephropathy was the most common cause of CKD followed by hypertension in 14.5% patients. 23% patients were in stage V, 19.44% patients in stage IV, 18.67% in stage III, 27.26% patients in stage II and 36.06% patients in stage I.[34]

The overall yearly incidence of ESRD in India is said to be approximately 150–200 pmp, diabetes being important cause of CKD in approximately 30–40% of the patients. Further, with increase in life expectancy the magnitude of CKD is going to increase even further. Further multicentric studies are needed to determine the

magnitude of the problem of CKD/ESRD in India involving both rural and urban populations.[40]

Classification

In 2002, KDOQI published its classification of the stages of chronic kidney disease,[45] as follows:

- Stage 1: Kidney damage with normal or increased GFR (>90 mL/min/1.73 m^2)
- Stage 2: Mild reduction in GFR (60-89 mL/min/1.73 m^2)
- Stage 3: Moderate reduction in GFR (30-59 mL/min/1.73 m^2)
- Stage 4: Severe reduction in GFR (15-29 mL/min/1.73 m^2)
- Stage 5: Kidney failure (GFR < 15 mL/min/1.73 m^2 or dialysis)

Etiology

Leading causes of chronic kidney disease include the following:[23]

- Diabetes
- Hypertension
- Vascular disease
- Glomerular disease (primary or secondary)
- Tubulointerstitial disease
- Urinary tract obstruction

Vascular diseases that can cause chronic kidney disease include the following:[29]

- Renal artery stenosis
- Cytoplasmic pattern antineutrophil cytoplasmic antibody (C-ANCA)–positive and perinuclear pattern antineutrophil cytoplasmic antibody (P-ANCA)–positive vasculitides
- Antineutrophil cytoplasmic antibody (ANCA)–negative vasculitides

- Atheroemboli
- Hypertensive nephrosclerosis
- Renal vein thrombosis
- Unrecovered acute kidney injury

Pathophysiology

The Brenner hypothesis[48] postulates that any critical loss of functioning renal mass, irrespective of the nature of the initial injury, leads to glomerular hyperfiltration with an increased single-nephron GFR. In presence of congenital and acquired single kidneys,[49] the remaining nephrons lose their ability to autoregulate glomerular pressure, resulting in direct transmission of systemic hypertension to the glomerulus. Elevated intraglomerular pressure induces glomerular and tubular hypertrophy. Endothelial and podocyte cell injury, resulting from disease-specific or nonspecific uremia-associated vasculotoxic and inflammatory insults, are frequently involved in progressive glomerular damage, inducing local inflammation and fibrosis.[50-51]

Furthermore, proteinuria (induced by increased intraglomerular pressure), is considered the pathophysiological link between glomerular, interstitial and tubular damage.[52,53] The degree of proteinuria in glomerular diseases correlates with the rate of renal-failure progression.[54]

Reabsorption of filtered proteins by the tubuloepithelial cells can induce direct injury to intracellular lysosomal pathways, oxidative stress, increased local expression of growth factors,[55,56] and release of chemotactic factors, which promote tubulointerstitial inflammation and fibrosis through recruitment and activation of macrophages.[57-62] Macrophages infiltrating the renal parenchyma, in turn, perpetuate the production of further cytokines and growth factors.

In both the glomeruli and tubuli, chronic inflammatory processes result in increased synthesis and reduced degradation of extracellular matrix, with excessive tubulointerstitial collagen accumulation. Consequential glomerular sclerosis, tubulointerstitial fibrosis, and tubular atrophy cause a further loss of functioning renal mass, thereby closing a vicious circle of disease progression by increasing intraglomerular pressure and hypertrophy of the remaining glomeruli.[23]

Angiotensin II is the primary effector of the RAS and is mechanistically involved in most of the pathways described above. Most of the intrarenal effects of angiotensin II are mediated via the type-1 angiotensin II receptor.[14-18]

Angiotensin II is a potent vasoconstrictor that augments the level of intraglomerular pressure by preferentially increasing the efferent arteriolar tone. Angiotensin II also increases intracellular calcium activity in podocytes, inducing cytoskeletal changes and altered podocyte function with induction of protein ultrafiltration even in the absence of structural glomerular damage.[23]

Moreover, angiotensin II increases the proliferation of smooth muscle cells and increases the glomerular and tubular expression of various growth factors, cytokines and chemokines. Angiotensin II stimulates oxidative stress, which perpetuates the upregulation of cytokines, adhesion molecules, and chemoattractants.[23] Angiotensin II also causes sympathetic hyperactivation, which is characteristic of CKD and constitutes another important mechanism of renal-disease progression and cardiovascular morbidity.[43]

Clinical presentation

History

Patients with chronic kidney disease stages 1-3 (glomerular filtration rate [GFR] >30 mL/min) are generally asymptomatic; Generally, these disturbances become clinically manifest with chronic kidney disease stages 4-5 (GFR < 30 mL/min).[23]

Clinical features:

- Fluid and electrolyte imbalance leading to peripheral edema, pulmonary edema and hypertension.[23]
- Anemia leading to increased cardiovascular mortality.[23]
- Pericarditis - Can be complicated by cardiac tamponade, possibly resulting in death
- Encephalopathy - Can progress to coma and death
- Peripheral neuropathy
- Restless leg syndrome
- GI symptoms - Anorexia, nausea, vomiting, diarrhea
- Skin manifestations - Dry skin, pruritus, ecchymosis
- Fatigue, increased somnolence, failure to thrive
- Malnutrition
- Erectile dysfunction, decreased libido, amenorrhea
- Platelet dysfunction with tendency to bleeding[48]

Diagnosis

Investigations include complete blood count (CBC),renal profile and urinalysis, Serum phosphate, serum calcium, alkaline phosphatase levels are obtained to look for evidence of renal bone disease and renal ultrasound to look for renal pathology .[26]

Normochromic normocytic anemia, elevated blood urea nitrogen (BUN) and creatinine levels, Hyperkalemia or low bicarbonate levels, Hypoalbuminemia due to urinary protein loss or malnutrition support diagnosis of chronic kidney disease.[23]

Treatment

In February 2014, the Canadian Society of Nephrology released new guidelines that recommend delaying dialysis in CKD patients without symptoms until their estimated glomerular filtration rate (eGFR) drops to 6 mL/min/1.73 m^2 or until the first onset of a clinical indication (which includes symptoms of uremia, fluid overload, and refractory hyperkalemia or acidemia).[50, 51] Close monitoring should begin when eGFR reaches 15 mL/min/1.73 m^2.

Measures indicated to delay or halt the progression of chronic kidney disease (CKD) are as follows:

- Treatment of the underlying condition if possible
- Aggressive blood pressure control with a target blood pressure of less than 130/80 mm Hg. [57]
- Low-protein diet to reduce proteinuria.[59] [60]
- Treatment of hyperlipidemia to target levels per current guidelines
- Aggressive glycemic control per the American Diabetes Association (ADA) recommendations (target hemoglobin A1c [HbA1C] < 7%)

- Avoidance of nephrotoxins, including intravenous (IV) radiocontrast media, nonsteroidal anti-inflammatory agents (NSAIDs), and aminoglycosides
- Use of angiotensin-converting enzyme inhibitors (ACEIs) or angiotensin-receptor blockers (ARBs) in patients with diabetic kidney disease (DKD) [52, 53, 54]
- Paricalcitol a synthetic vitamin D analogue, approved by the US Food and Drug Administration (FDA) for the prevention and treatment of secondary hyperparathyroidism associated with CKD stage 5.[61] .[62, 63]
- Encourage smoking cessation, as smokers tend to reach ESRD earlier than nonsmokers.[65]
- Salt restriction of less than 2500mg/day to retard the progression of ckd by lowering the blood pressure. [29 30]

Treating Pathologic Manifestations of Chronic Kidney Disease

Treat these pathologic manifestations of chronic kidney disease (CKD) as follows:

- Anemia: Use of Erythropoiesis-stimulating agent (ESA) such as epoetin alfa or darbepoetin to achieve goal of hemoglobin level of 10-12 g/dL, as normalization of hemoglobin in patients with CKD stages 4-5.Before starting erythropoietin, patients should have their iron stores checked. The aim is to keep iron saturation at 30-50% and ferritin at 200-500 ng/mL.
- Hyperphosphatemia: Treat with dietary phosphate binders (eg, calcium acetate, sevelamer carbonate, lanthanum carbonate) and dietary phosphate restriction[37 38]
- Hypocalcemia: Treat with calcium supplements with or without calcitriol
- Hyperparathyroidism: Treat with calcitriol, vitamin D analogues, or calcimimetics

- Volume overload: Treat with loop diuretics or ultrafiltration
- Metabolic acidosis: Treat with oral alkali supplementation (to maintain the serum bicarbonate concentration above 22 mEq/L)
- Uremic manifestations: Treat with long-term renal replacement therapy (hemodialysis, peritoneal dialysis, or renal transplantation)
- Cardiovascular complications: Treat as appropriate
- Growth failure in children: Treat with growth hormone[49-52]

Renal Replacement Therapy

Indications for renal replacement therapy in patients with chronic kidney disease (CKD) include the following[42]:

- Severe metabolic acidosis
- Hyperkalemia
- Pericarditis
- Encephalopathy
- Intractable volume overload
- Failure to thrive and malnutrition
- Peripheral neuropathy
- Intractable gastrointestinal symptoms
- In asymptomatic adult patients, a glomerular filtration rate (GFR) of 5-9 mL/min/1.73 m^2, [18-22] irrespective of the cause of the CKD or the presence of absence of other comorbidities .

HEMODIALYSIS :

Hemodialysis fistulas are surgically created communications between the native artery and vein in an extremity. Direct communications are called native

arteriovenous fistulas (AVFs). Polytetrafluoroethylene (PTFE) and other materials (Dacron, polyurethane, bovine vessels, saphenous veins) are used or have been used as a communication medium between the artery and the vein and are termed prosthetic hemodialysis access arteriovenous grafts (AVGs). The access that is created is routinely used for hemodialysis 2-3 times per week.[1, 2, 3]

Many patients who are not candidates for renal transplantation or those for whom a compatible donor cannot be secured are dependent on hemodialysis for their lifetime. This situation results in the long-term need for and use of dialysis access. The preservation of patent, well-functioning dialysis fistulas is one of the most difficult clinical problems in the long-term treatment of patients undergoing dialysis. As many as 25% of hospital admissions in the dialysis population have been attributed to vascular access problems, including fistula malfunction and thrombosis.[4]

Historically, native fistula or graft malfunction and thrombosis were treated by using surgical thrombectomy and revision, resulting in the eventual exhaustion of the veins and the need to create a new access. Initially applied in the 1980s, percutaneous techniques such as balloon angioplasty (percutaneous transluminal angioplasty [PTA]), thrombolysis, and mechanical thrombectomy allowed the treatment of stenosis and fistula thrombosis without surgery.

In the past 2 decades the coordinated multidisciplinary management of dialysis access by interventional radiologists, vascular surgeons, and nephrologists has proven extremely effective in prolonging the patency of the vascular access and decreasing the morbidity and mortality of patients with chronic renal failure.[5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16]

Causes of dialysis fistula failures

All observations and publications reported to date indicate that for prosthetic grafts, fistula failure and eventual occlusion occur most commonly as a result of the progressive narrowing of the venous anastomosis; for native fistulas, failure occurs most commonly as a result of the narrowing of the outflow vein. The primary underlying pathophysiologic mechanism responsible for causing the failure is intimal hyperplasia at the anastomotic site. Additional causes include surgical and iatrogenic trauma, such as repeated venipunctures.[13-16]

Vascular Mapping:

The population of patients with ESRD is progressively increasing, with hemodialysis as the major mode of renal replacement therapy.[61 ,62,63] Of the 3 types of hemodialysis vascular access, arteriovenous fistulae (AVF) have higher patency rates,[62] lower infection rates, and lower overall costs[1] than either grafts or catheters. As a result, the National Kidney Foundation's Dialysis Outcomes and Quality Initiative recommends that AVF be placed in 40% of all prevalent dialysis patients.[25] Further Fistula First Initiative, jointly formed by the Center for Medicare and Medicaid Services and the ESRD networks increased the target to 66% of prevalent hemodialysis patients.[5]28

Despite these recommendations, the majority of patients initiate hemodialysis with a central venous catheter as their access.[1,6] This may, in part, be attributed to the fact that AVF have a high rate (20%-50%) of primary failure that precludes their successful use for dialysis.[7] In addition, surgeon selection may have a significant impact on the rate of placement and maturation of an AVF.[48] Frequent phlebotomies, peripherally inserted central catheters lines,and a high prevalence of comorbid

conditions including diabetes, obesity, and vascular disease[31] may negatively impact the vasculature and contribute to early AVF dysfunction. Consequently, the selection of suitable vessels by preoperative vascular mapping is recommended before AVF creation for both predialysis CKD and ESRD patients on hemodialysis.

Vascular mapping involves evaluation of both arterial and venous upper-extremity systems before access placement. One of 3 techniques may be used: physical examination, ultrasonography, and angiography.

Physical examination

A simple bedside assessment may be performed to evaluate the patency of the arterial and the venous systems. A tourniquet is placed at the upper extremity, and the veins are inspected to assess the caliber, the length of a straight venous segment suitable for cannulation, and the distance of the vein from the skin surface.[30] Arterial evaluation includes the documentation of strong pulses and blood pressure measurements in both extremities. The Allen test should be performed before the creation of any forearm AVF to assess the patency of the palmar arch. Although an upper-extremity physical examination can be valuable, when used alone, it may be inadequate to identify suitable vasculature, particularly in obese patients or those with a history of prior vascular access, and is often supplemented with additional techniques, such as ultrasonography.[32]

Ultrasound Examination

Ultrasonography provides a noninvasive and objective assessment of the arterial and venous systems before AVF creation. The preoperative criteria currently thought to promote successful AVF maturation include a minimal arterial diameter of

20 mm and a minimal venous diameter of 25 mm identified in either upper extremity.[38]

The technique for vessel ultrasonographic imaging are as follows:[36-39] The forearm is evaluated first, with the patient's arm comfortably positioned approximately 45° from the body. Evaluation of the upper-extremity arteries includes the measurement of diameter, distance from the skin, arterial flow, and the presence of calcifications and/or other abnormalities like thrombosis. Both radial and ulnar arterial diameters are evaluated and if they are 20mm or smaller then the arteries are not suitable for forearm AVF creation, the brachial artery is then assessed with similar measurements.

Venous system evaluation is done in the entire upper extremity starting from the cephalic vein in the forearm to the cephalic and basilic veins in the upper arm. A tourniquet is placed at the midforearm, antecubital area, and at the upper arm, and the cephalic, basilic, and brachial vein diameters are measured throughout their course up to their insertion into the subclavian or axillary veins. The draining and central veins are assessed for stenosis or thrombosis by analysis of the waveform for changes in respiratory phasicity and transmitted cardiac pulsatility[42].

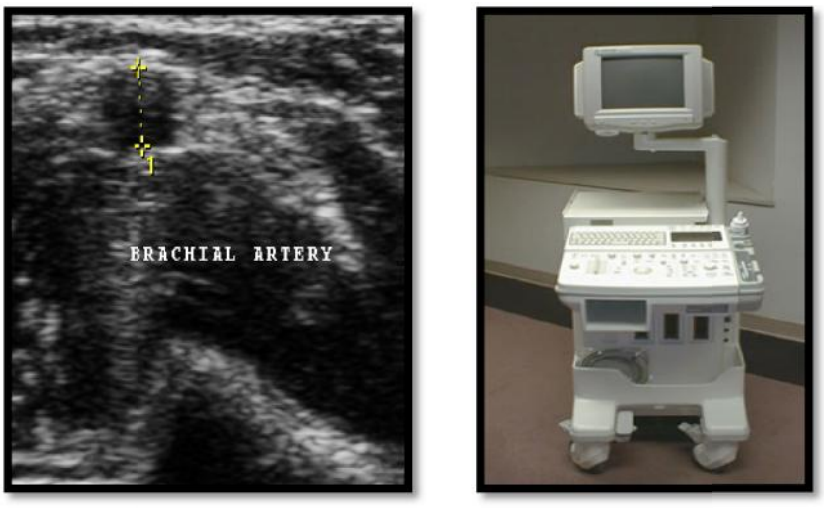


Figure 6:Usgcolour Doppler

Angiography

Vascular mapping can also be conducted via radiocontrast administration,[41] although it is primarily the veins that are evaluated with this technique. A peripheral vein on the dorsum of the hand is cannulated, and the arm is then placed in the anatomic position. Sequential tourniquets are then applied, one at the elbow and the other at the axilla. Low isoosmolar contrast diluted with normal saline is injected through the cannula, and images are obtained throughout the course of the veins using calibrated pulse fluoroscopy. The lower tourniquet may be removed once the forearm is examined to allow contrast to pass into the upper arm. The criteria used to determine suitability of veins for AVF placement are the same as those for ultrasonography[43]: vein diameters of at least 25 mm and patent draining and central veins. It is useful that both the cephalic and basilic venous systems be imaged to delineate relevant anatomy.

To date, no randomized studies have compared the various techniques for AVF vascular mapping. Nonetheless, each technique has advantages in certain clinical settings.

In a European analysis of 145 consecutive patients referred for vascular access surgery, 106 patients (73%) proceeded to vascular access surgery on the basis of clinical examination alone, with favorable (77%) subsequent patency results.[18] However, because an increasing proportion of the hemodialysis population in the United States has multiple comorbidities that may affect the vasculature as well as a high prevalence of central venous catheter use, physical examination alone may be insufficient in the vast majority of these patients.

In another recent study,lemson et al[44] done on 116 patients , 54(46.5%) had clinically visible veins, 62 patients underwent ultrasonographic examination of which (48 patients, 77.4%) were found to have adequate veins for successful AVF creation.[52] Therefore, ultra-sonography has the advantage of providing noninvasive assessment of both venous and arterial systems as well as indirect assessment of central venous patency, without exposure to radiation or potentially nephrotoxic contrast.

Role of Vascular Mapping To Maximize AVF

In a study,sedlaceak et at[47] which compared primary failure rates and patency rates of AVF before and after the institution of ultrasonographic assessment of the upper extremity vasculature,[13] resulted in a significant increase in the creation and use of AVF, with a reduction in early AVF failure rates and an increase in cumulative AVF patency. Other researchers have observed similar results after the implementation of the various techniques for preoperative evaluation, including physical examination, ultrasonography, angiography, or a combination as well as institution of a comprehensive multipronged approach to maximize AVF placement.[14,21–26]

A preoperative strategy to identify suitable vessels for AVF creation would translate into decreased early failure rates.

In a study,stehmeen breen et al[52], routine preoperative vascular mapping resulted in a marked increase in AVF creation and an increased maturation rate for forearm AVF; however, it did not improve the maturation of upper arm AVF.[22]

In a silva MB et al[55], the implementation of preoperative ultrasonography and angiography to aggressively increase AVF creation resulted in a greater number of AVFs, but had the unintended consequence of reducing the AVF maturation rate from 73% to 57%.[27] The authors attributed the decline to a change in practice patterns, with more complex surgeries being performed in the study group as compared with historic controls. Furthermore, they did not routinely perform ultrasonography in all patients and reserved the technique for those patients in whom physical examination was inadequate to identify suitable vessels for AVF placement.

A synopsis of the evidence in this field is summarized in Table 1. In most cases, the primary outcome of previous studies has been AVF creation, rather than AVF maturation or usability, and only 2 of the 12 previous studies report favorable outcomes related to venous mapping and AVF maturation. It must also be noted that the studies showing a benefit of preoperative mapping are not randomized and were published in parallel with the promotion of AVF creation by major national initiatives.[4,5]

Preoperative vessel mapping increases AVF creation,[43,44,21,23–26] although there is limited and conflicting evidence regarding the effect of vessel mapping on AVF maturation.[22,27] Currently, there is no evidence to support one vessel mapping technique over another; therefore, we believe that the technique used should be individualized to the patient, with careful consideration of the advantages and disadvantages of each method. Selective, rather than the routine use of ultrasonography, in patients with poorly defined vessels on physical examination may limit costs and at the same time expedite placement of fistulae by early referral for surgery.[18] Although minimal vessel diameter criteria have been established for

ultrasonography,[13] these clearly have limitations, as evidenced by the poor AVF maturation rates reported in the DAC study; therefore, variables including resistive indices, internal vessel diameter, and blood flow before and after reactive hyperemia might be considered in order to maximize AVF placement and maturation.[15,28,29] Future research should focus on prospective, randomized controlled trials to evaluate the efficacy of preoperative mapping techniques on the creation, maturation, and patency of AVF.

Kidney Disease Outcomes Quality Initiative guidelines5 define an order of preference for placement of vascular access in patients with kidney failure who will become hemodialysis dependent:

1. The nondominant arm is usually preferable for dialysis access placement and is usually evaluated first. A forearm AVF is preferred over an upper arm AVF, although a dominant forearm AVF is generally preferred over a nondominant upper arm AVF.
2. A forearm cephalic vein AVF (radial artery–cephalic vein), followed by an upper arm cephalic vein AVF (brachial artery–cephalic vein), is preferred.
3. If it is not possible to create either of these fistulae, access may be established using a transposed basilic vein fistula (brachial artery–basilic vein), or other AVF configuration.
4. If the vascular anatomy is not suitable for any AVF placement, a graft of synthetic material (eg, polytetrafluoroethylene [PTFE]) may be placed. A forearm loop graft (brachial artery to antecubital vein) is preferred over an upper arm straight graft (brachial artery to basilic vein). If no other upper extremity access is possible, an upper arm loop

graft (axillary artery to axillary vein) may be placed if the anatomy is suitable.

5. Thigh grafts (superficial femoral artery to great saphenous vein or common femoral vein) are the next usual site for access placement. Placement of an upper extremity AVF or an arm or thigh graft is preferred to catheter based hemodialysis due to increased catheter infection rates and often lower catheter flow rates compared to a graft or fistula.7

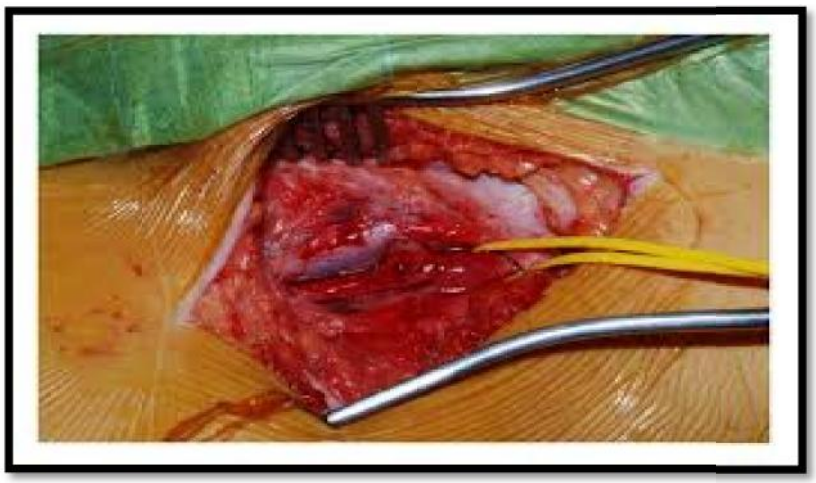


Figure 7: A-V Fistula

Indications/Contraindications

Indications for vascular mapping for preoperative planning of dialysis access include planning of vascular access for hemodialysis. There are no absolute contraindications for this examination.

The ultrasound examination for dialysis access planning is designed to gather information about both the arterial system and the venous system. It is important to understand the procedure and surgical techniques to be used by the local dialysis access surgeon(s) to obtain information tailored to the technique.

The examination is done either on both arms or only on one arm. If a unilateral examination is chosen, the nondominant arm is examined first unless there is a known contraindication to the use of this arm. The artery used must be of sufficient size (diameter >0.20 cm) to construct the fistula and to have adequate flow for maturation[64]. This size may vary according to surgical preference. The artery is first evaluated with gray scale and spectral Doppler imaging. The diameter of the artery is measured at the level of expected fistula creation. The presence of calcification is recorded and reported because the surgical anastomosis can be difficult if significant concentric calcification is present. Arterial spectral waveforms should be assessed to screen for inflow or outflow disease. For a forearm AVF, the diameter, presence of calcification, and peak systolic/end-diastolic velocities of the radial artery are assessed at the wrist[63]. Ulnar arteries may be similarly assessed. For either AVF or graft creation, the brachial artery is assessed at the antecubital fossa for the diameter, presence of calcification, and peak systolic/end-diastolic velocities. An artery in the antecubital fossa that is smaller than expected, or the presence of 2 arteries at this site, is a clue that there is a high bifurcation of the brachial artery (high radial artery) takeoff. This vascular anomaly occurs in 5% to 10% of patients[45]. This anatomic variant should be confirmed by imaging the radial and ulnar arteries to determine at what level they arise from the brachial artery.

A modified duplex Allen test may be performed to evaluate flow to the hand (patency of the deep palmar arch). This is done by identifying the radial artery at the wrist and/or at the dorsum of the hand (posteriorly between the bases of the first and second metacarpals). The radial artery is compressed proximal to this site to occlude flow during spectral and color Doppler imaging. Reversal of blood flow distal to the proximal occlusion confirms patency of the palmar arch[38].

Venous Examination: The examination is focused first toward finding a vein suitable for AVF creation. If no suitable vein is found, veins suitable for graft creation are sought. The vein mapped to receive the arterial anastomosis should be measured after it is dilated. This measurement will more closely approximate the size of the arterialized vein after fistula formation. The vein is generally dilated by use of sequential tourniquet placement or an inflated blood pressure cuff on the arm.[59] Percussion in the region of the wrist after tourniquet placement for 2 to 3 minutes can increase the size of the veins, similar to starting an intravenous line. Other suitable dorsal or volar caudal forearm veins may be identified with this technique. The forearm vein most commonly used for AVF creation is the cephalic vein. The anastomosis is usually created at the wrist or in the lower third of the forearm. The cephalic vein is imaged at the site of the expected anastomosis at the wrist. It is assessed for compressibility, thrombus, and size. Measurements are obtained with a minimal diameter of 25 mm for all veins used for an AVF[60]. There may be variations in the diameter used based on clinical factors or surgical preference. The vein diameter is measured at the caudal, mid, and cranial forearm; at the antecubital fossa; and at the caudal, mid, and cranial upper arm, as applicable. The sites and length of any venous stenosis are noted. Veins that are borderline in size (within 15 mm of the desired size) are measured again after more focused percussion or after application of a warm compress for several minutes.

The cephalic vein should be evaluated throughout the entire arm to its insertion into the subclavian vein. Note that the forearm cephalic vein may drain preferentially via a large antecubital vein into the basilic or brachial veins if the upper arm cephalic vein is too small or thrombosed. In this case, placement of a forearm fistula is still possible as long as diameter thresholds are maintained. Veins must be

relatively superficial to be easily cannulated after placement of a fistula. The depth from the skin surface to the cephalic veins of adequate diameter may be measured to assess the need for a subsequent superficialization procedure.[50] If the cephalic vein in the forearm is inadequate for fistula creation, other veins in the forearm may be examined to determine whether they are adequate. These veins in general will need to be transposed to a more easily accessible position in the anterior surface of the forearm. If no suitable vein is found in the forearm, the veins in the upper arm should be evaluated. The upper arm cephalic vein should be examined for upper arm fistula creation. If it is too small or thrombosed, the basilic vein is evaluated. The basilic vein needs to be of adequate size for at least 4 cm in length, caudal to the antecubital fossa, so there is enough vein length to create a basilic vein transposition AVF in the upper arm[52].

If no suitable upper arm vein for AVF creation is found, the largest brachial vein and the axillary vein should be measured for potential graft placement as previously described. A vein with a diameter of at least 4 mm is needed for grafts. Similar assessment techniques should be used for all veins. Large branches of veins near the site of a fistula can result in nonmaturation of the fistula.[41,42] The sites and sizes of vein branches may be noted.

The internal jugular and subclavian veins should be examined bilaterally to document symmetric respiratory phasicity and transmitted cardiac pulsatility as well as to exclude outflow stenosis. These veins should be evaluated with compression, if possible, with gray scale, spectral, and color Doppler imaging. Unilateral or bilateral monophasic waveforms or low-velocity venous waveforms are abnormal.[53,54] Abnormal waveforms in the jugular or subclavian veins should prompt further

evaluation of the brachiocephalic veins and/or superior vena cava (SVC) by magnetic resonance imaging, computed tomography, or conventional venography if access placement on that side is desired.

Real-time imaging should be conducted at the highest clinically appropriate frequency. Frequency of 10 to 12 MHz or greater, with the occasional need for a lower-frequency transducer. A linear transducer should be used. Flow analyses are performed with duplex sonography using pulsed Doppler imaging. Evaluation of the flow signals originating from within the lumen of the vessels should be conducted with a carrier frequency of 2.5 MHz or greater[53].

Ultrasound can be extremely useful in the evaluation of many problems faced by the hemodialysis patient.[31] Preoperative US mapping for hemodialysis access placement can facilitate better selection of functional vessels thereby decreasing unsuccessful surgical explorations.[26]

Different outcomes of AVF have been reported in studies examining the effect of preoperative evaluation. The relevant parameters measured to evaluate the potential patency of the AVF are the arterial and venous diameter and vessel morphology.[53]

Arterial criteria: The arterial diameter has been studied in radiocephalic AVF. Immediate and early AVF failures are well recognized when very small calibre arteries <16 Mm are used for AVF construction. One study reported 55% immediate and 64% early failure rate for arteries of 15 mm diameter or below, compared to 8% and 17%, respectively, for arteries >15 mm[49]. Therefore, the larger the arterial diameter the more certain is AVF patency. A minimum diameter of 15 mm was finally suggested by one study which reported good AVF outcomes (8% early failure, 83% functional primary patency at 1 year)[55]. There are no diameter recommendations

for the brachial artery, but because of its larger calibre, diameter measurement may be less crucial for AVF outcome. Ultrasound is also useful in identifying common anatomical variations like early division of brachial artery which may affect the number and calibre of arteries found at the level of elbow. Radial artery wall changes due to arterial disease are common in patients with end-stage renal disease and worse in patients with diabetes or renovascular disease[61]. Pre-existing arterial disease which can be effectively assessed by ultrasonography is important for AVF outcome.

Venous Criteria: A minimum diameter of 25 mm with tourniquet was first suggested by Silva who reported good AVF outcomes (8% early failure, 83%) functional primary patency at 1 year) though there is no agreed minimum venous diameter to predict radiocephalic AVF maturation. Criteria for upper arm veins are not established but a diameter of at least 3 mm has been recommended[66,67].

Several US American studies were recently published which showed good or improved AVF outcomes achieved with the use of pre-operative ultrasound. Almost all report a higher rate of AVF in preference to arteriovenous grafts (AVG) and better primary patency AVF.

METHODOLOGY

Source of data:

50 patients planned for haemdialysis access placement referred from Department of Nephrology, KLES J.N.MEDICAL COLLEGE, BELGAUM were incuded in study.

This study was conducted between JAN 2015-DEC 2015

Method of collection of data

Prospective study of 50 patients.

Preferred site of access placement is planned by Duplex ultrasonography by evaluation of vessel size, wall morphology and patency of the vessels based on the criteria of access placement for fistula formation.

Inclusion criteria

All cases planned for surgical AVF construction in upper limb for haemodialysis access placement were included in study.

Exclusion criteria

1. Deformed or scarred upper limb
2. Upper limb arterial disorder like Raynauds
3. Imminent renal transplant from living donor
4. Heart valve disease or prosthesis
5. Previous arm, neck or chest surgery/trauma

6. Extremely obese patients
7. All other patients where AVF for haemaccesss is contraindicated or technically not feasible

Equipment and protocol

Duplex ultrasonography

This study was done using Voluson 730 Pro, GE Logiq 500 pro ultrasound scanners using Linear array probes with a frequency of 7 MHZ or higher for B-mode, and 5MHZ or higher for Doppler. The anatomy under examination by ultrasound is checked in both transverse and longitudinal sections. Following observations are made

B-mode

1. Recipient and donor vessel size
2. Assessment of vascular anatomy
3. Wall thickness
4. Identification of the presence of cephalic vein branches needing ligation to prevent diversion of flow from the fistula
5. Compressibility of the vein.

Colour flow and doppler are used when required

1. Assessment of vessel patency.
2. Venous flow disturbances-ex: to study subclavian vein patency as stenos is there leads to early failure.

3. Evaluation of Arterial flow (subclavian, brachial and radial) using waveform analysis.

After the evaluation of the vessels by sonography , selection of site was done based on the Haemodialysis Access selection criteria.

Hemodialysis access selection criteria:

An optimal access is recommended on the basis of the US evaluation of the patient's anatomy, according to the following preferential order of access placement. Forearm AVF.—Adequate distal radial arterial diameter, 2.0 mm or greater, and a cephalic vein 2.5 mm or larger throughout its entire course into the subclavian vein are suitable. Drainage of the cephalic vein into a large (2.5-mm) forearm median cubital vein and brachial or basilic vein also is acceptable. Upper arm AVF.—There is no acceptable vein-artery combination in the forearm. An adequately sized cephalic or basilic vein in the upper arm without stenosis or occlusion is suitable. A cephalic vein AVF is preferred to a basilic vein transposition because it has less potential morbidity and spares the upper arm.

Surgical correlation

The ultrasonographic result was then correlated with per-operative size of the vessel used, surgical procedure and outcome. Correlation was performed to determine the selection of access site. The discrepencies found between the US and operative findings were also evaluated. Sizes of the vessel used for fistula formation was noted and measured. The diameter of the vessel selected was measured with the help of a micrometer caliper .

Outcome

Followup of the patients was done at 3rd day and at the end of three months to assess the flowrate and patency of fistula.

Study design

Hospital based one year prospective study.

Method of statistical analysis

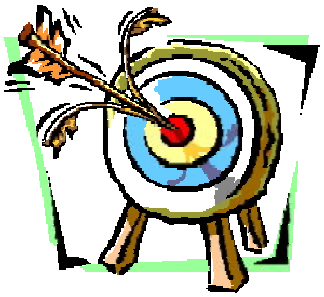
The following methods of statistical analysis have been used in this study.

1. Proportions were compared using Chi-Square (2) test
2. Student "t' test-The student't' test was used to determine whether there was a statistical difference between male and female subjects in the parameters measured.

Ethical clearance

Ethical clearance has been obtained

Introduction



Objectives

Review of Literature

Methodology

Results

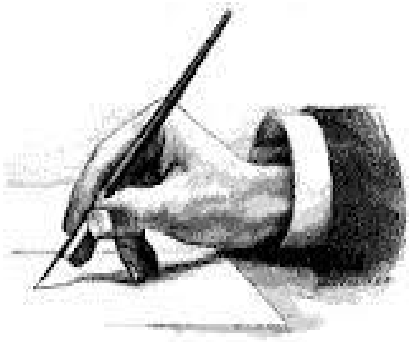
Discussion

Conclusion

Scope Of The Study

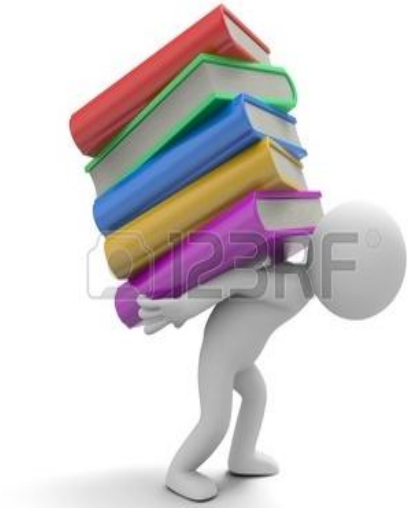
Summary

Bibliography



Annexure-I

Annexure-II



Annexure-III

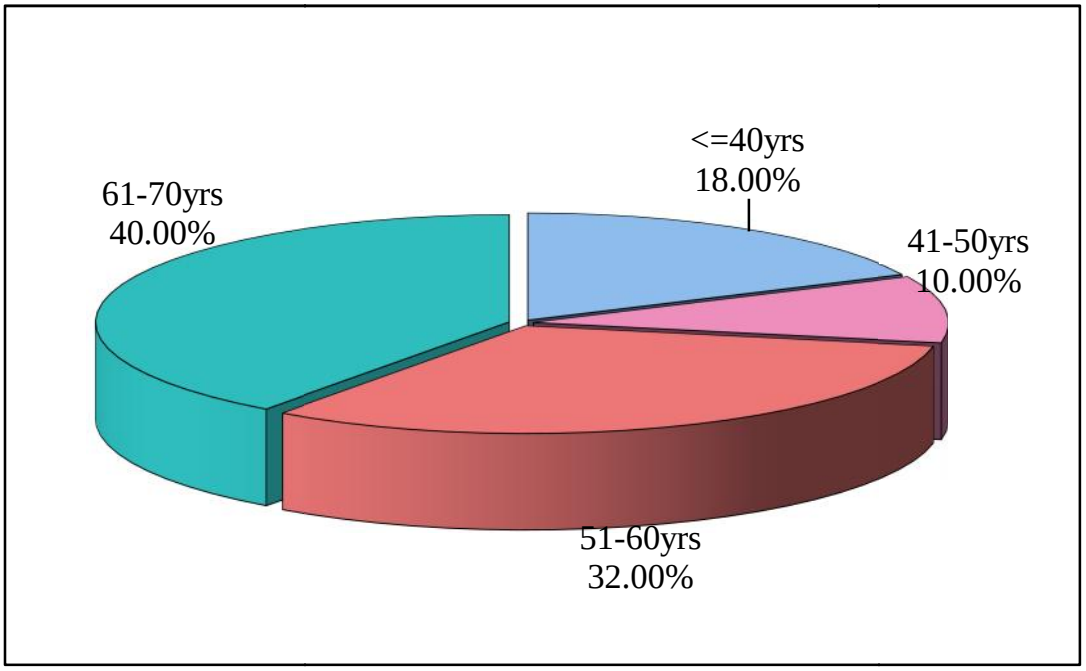
RESULTS

This study was conducted in KLES Dr. PRABHAKAR KORE HOSPITAL between January 2015 to december 2015.

4.1 AGE WISE DISTRIBUTION OF PATIENTS

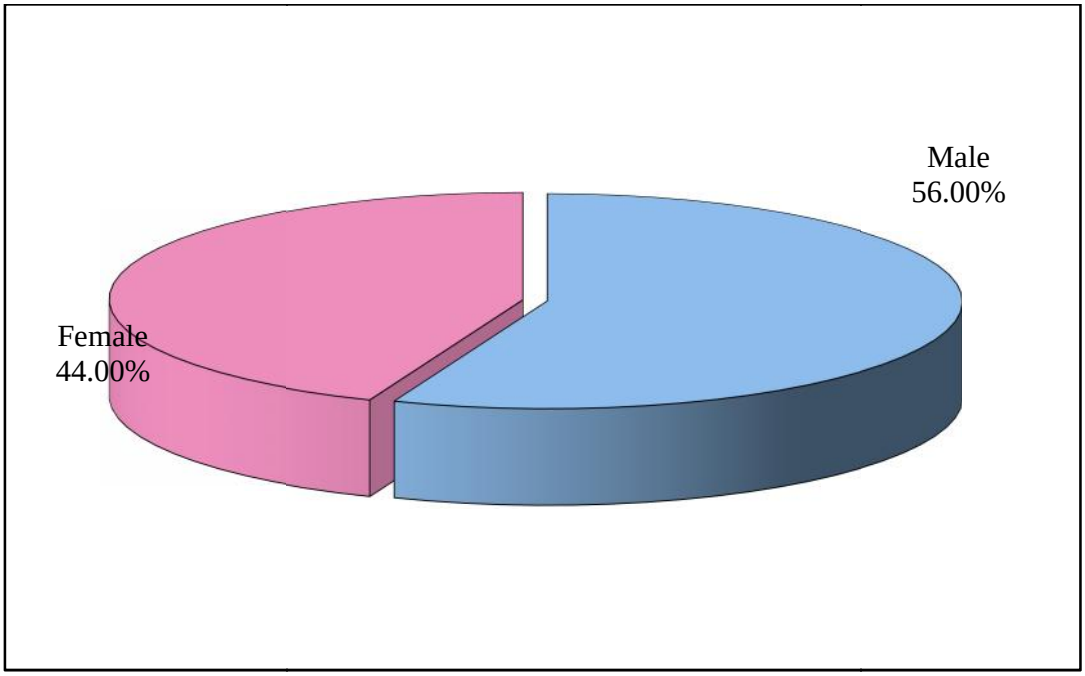
Age groups	No of patients	% of patients
<=40yrs	9	18.00
41-50yrs	5	10.00
51-60yrs	16	32.00
61-70yrs	20	40.00
Total	50	100.00
Mean age	55.44	
SD age	14.16	

GRAPH1: AGE WISE DISTRUBUTION OF PATIENTS



In the present study highest number of cases were between the age group of 61-70 years (40%) followed by 51-60 years (32%). The mean age was 55.44 years.

GRAPH 2 :GENDER DISTRIBUTION

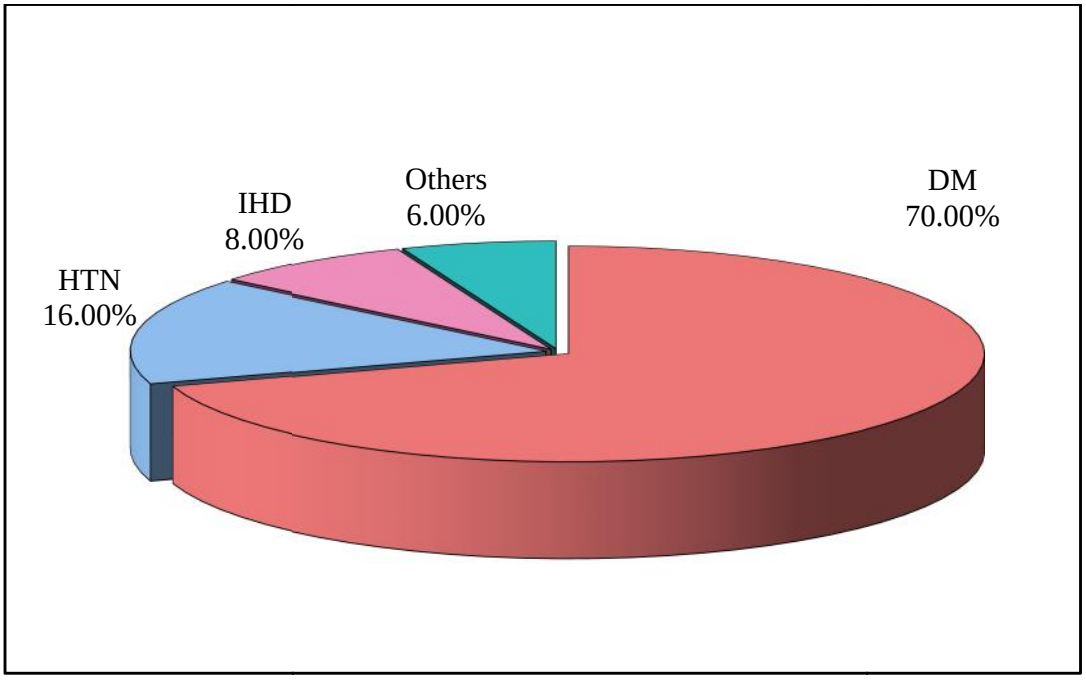


In the present study 56% were male and 44% were female.

4.2 TABLE: DISTRIBUTION OF THE STUDY POPULATION ACCORDING TO CLINICAL HISTORY

Clinical History	No of patients	% of patients
DM	35	70.00
HTN	8	16.00
IHD	4	8.00
Others	3	6.00
Total	50	

GRAPH 3: DISTRIBUTION OF THE STUDY POPULATION ACCORDING TO CLINICAL HISTORY

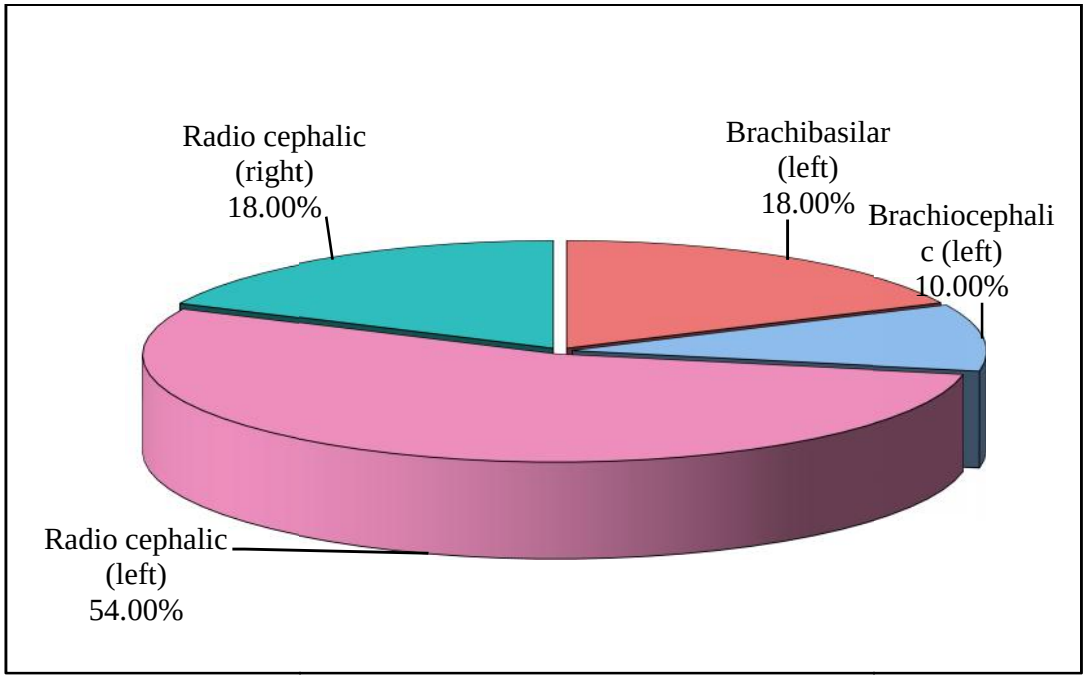


In the present study, among 50 cases of CKD 70% cases were secondary to DM, followed by hypertension (16%),Ischemic heart disease(8%), other diseases (6%).

4.3 TABLE: DISTRIBUTION OF PATIENTS BY SITE SELECTION OF AV FISTULA

Fistula	No of patients	% of patients
Brachiobasilar (left)	9	18.00
Brachiocephalic (left)	5	10.00
Radio cephalic (left)	27	54.00
Radio cephalic (right)	9	18.00
Total	50	100.00

GRAPH 4: DISTRIBUTION OF PATIENTS BY SITE SELECTION OF AV FISTULA:



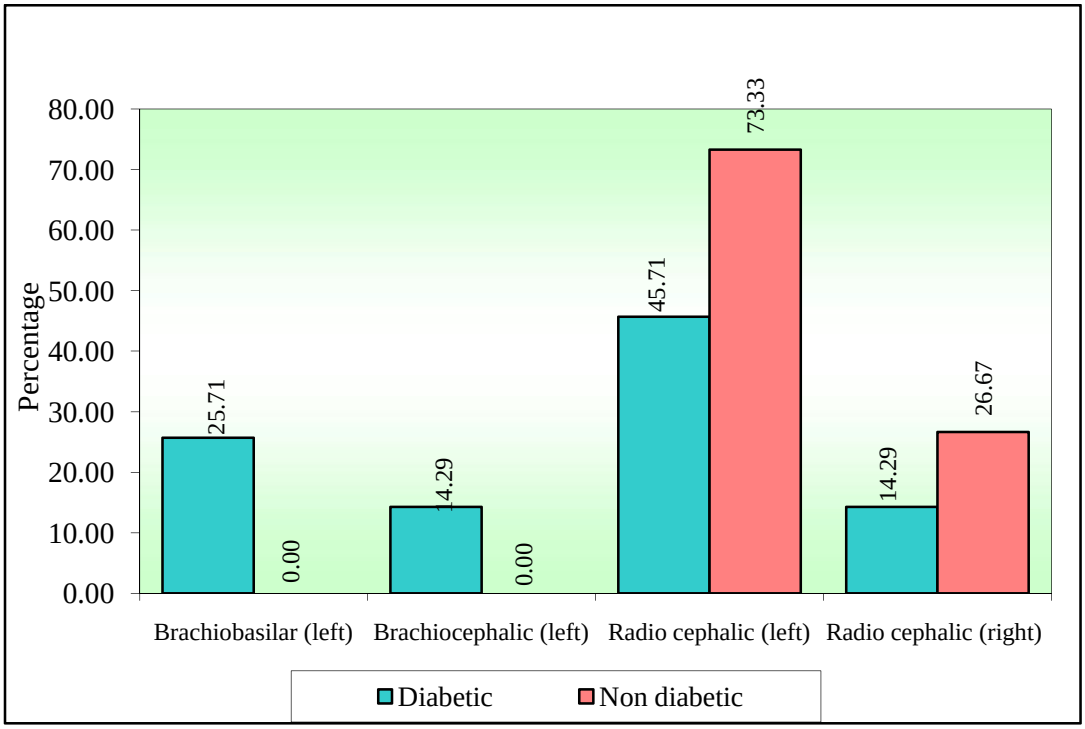
In the present study majority of patients underwent radio cephalic fistula placement (54%) followed by brachiobasilar (18%), followed by braciocephalic (10%) and surgery was considered in opposite hand in 18% of cases.

4.4 TABLE: DISTRIBUTION OF AV FISTULA IN PATIENTS WITH DIABETES MELLITUS

Fistula	Diabetic	%	Non diabetic	%	Total	%
Brachiobasilar (left)	9	25.71	0	0.00	9	18.00
Brachiocephalic (left)	5	14.29	0	0.00	5	10.00
Radiocephalic (left)	16	45.71	11	73.33	27	54.00
Radiocephalic (right)	5	14.29	4	26.67	9	18.00
Total	35	100.00	15	100.00	50	100.00
Chi-square=8.3772 p = 0.0153*						

*p<0.05

GRAPH 5:DISTRIBUTION OF AV FISTULA IN PATIENTS WITH DIABETES MELLITUS:

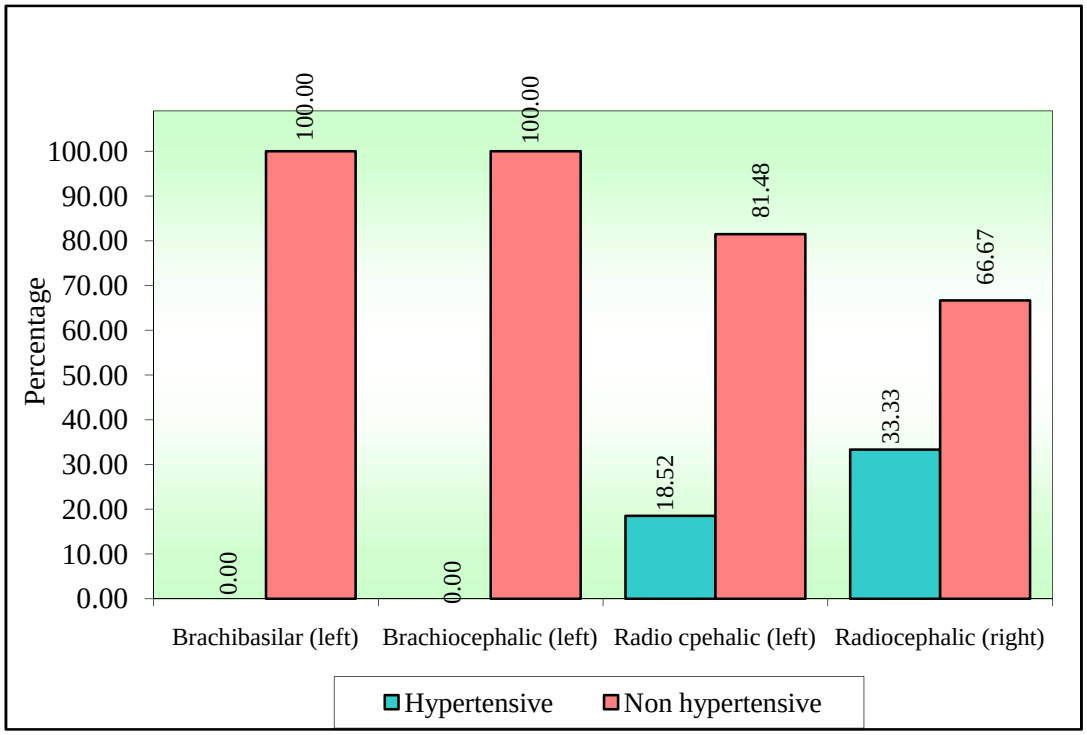


In the present study, among 35 diabetic patients,45% underwent radiocephalic fistula (left hand),25% underwent brachiobasilar (left hand),14% brachiocephalic (left hand),and 14% underwent radiocephalic fistula (right hand).

.4.5 TABLE: DISTRIBUTION OF AV FISTULA IN PATIENTS WITH HYPERTENSION

Fistula	Hypertensive	%	Non hypertensive	%	Total	%
Brachiobasilar (left)	0	0.00	9	100.00	9	18.00
Brachiocephalic (left)	0	0.00	5	100.00	5	10.00
Radio cepahalic (left)	5	18.52	22	81.48	27	54.00
Radiocephalic (right)	3	33.33	6	66.67	9	18.00
Total	8	16.00	42	84.00	50	100.00
Chi-square 4.8062 P = 0.0901						

GRAPH 6: DISTRIBUTION OF AV FISTULA IN PATIENTS WITH HYPERTENSION



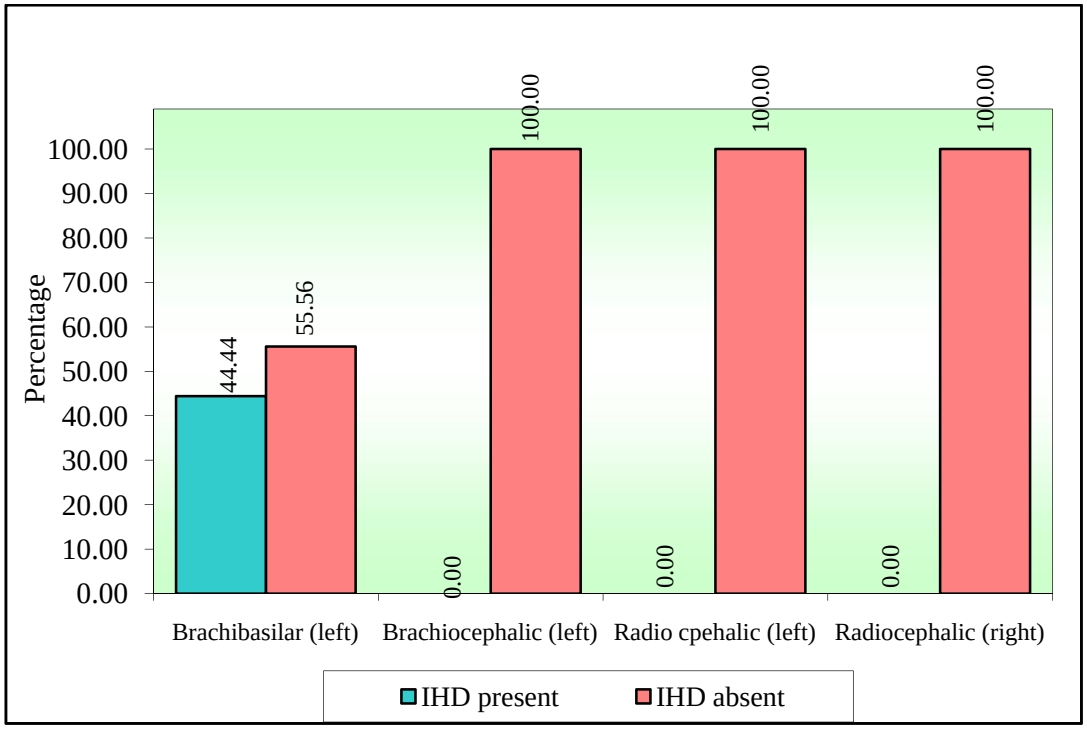
In the present study, among 8 hypertensive patients 18% underwent radiocephalic fistula (left hand),and 33%, underwent radiocephalic fistula (right hand)

4.6 TABLE: DISTRIBUTION OF FISTULA BY IHD WITH DIABETES AS CLINICAL HISTORY

Fistula	IHD present	%	IHD absent	%	Total	%
Brachiobasilar (left)	4	44.44	5	55.56	9	18.00
Brachiocephalic (left)	0	0.00	5	100.00	5	10.00
Radio cephalic (left)	0	0.00	27	100.00	27	54.00
Radiocephalic (right)	0	0.00	9	100.00	9	18.00
Total	4	8.00	46	92.00	50	100.00
Chi-square=11.1801 P = 0.0042*						

*p<0.05

GRAPH 7:DISTRIBUTION OF FISTULA BY IHD WITH DIABETES AS CLINICAL HISTORY

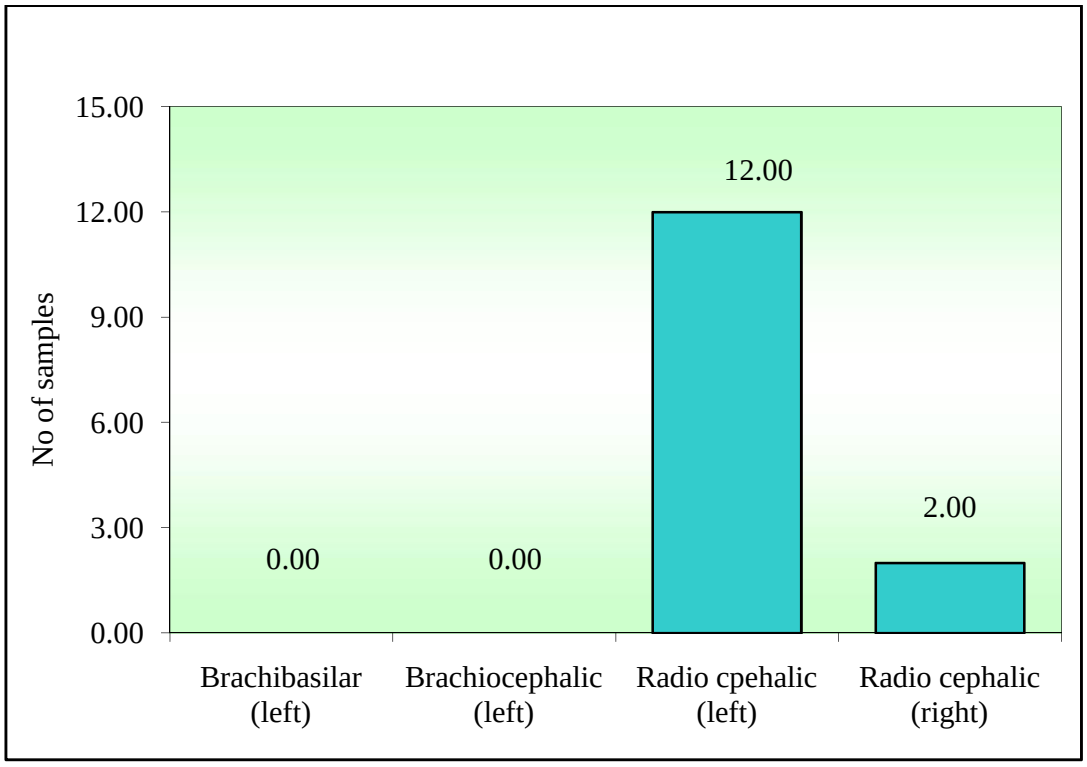


In the present study, among 4 Ischemic Heart Disease with diabetes patients, all underwent brachiobasilar fistula (left hand) in view of inadequate size of vessels at wrist due to atherosclerosis.

4.7 TABLE: DISTRIBUTION OF AV FISTULA IN PATIENTS OTHER THAN DM, HTN AND IHD

FISTULA	Others	%
Brachiobasilar (left)	0	0.00
Brachiocephalic (left)	0	0.00
Radio cephalic (left)	6	12.00
Radiocephalic (right)	1	2.00
TOTAL	7	14.00

GRAPH 8: DISTRIBUTION OF AV FISTULA IN PATIENTS OTHER THAN DM , HTN AND IHD

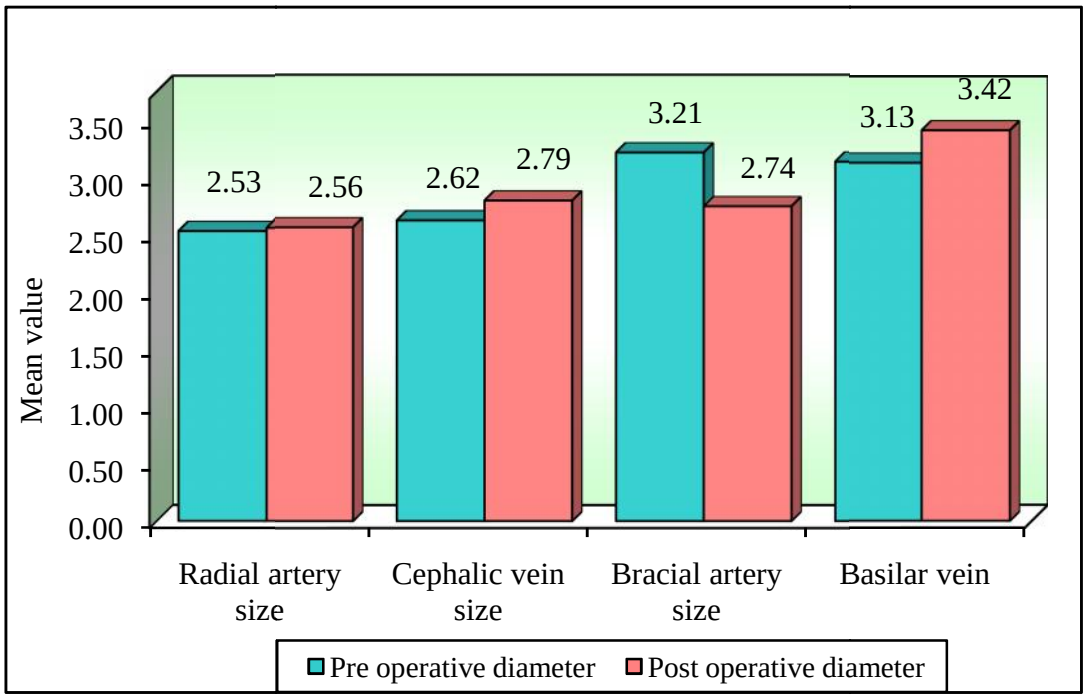


4.8TABLE: CORRELATION BETWEEN PRE OPERATIVE AND INTRA OPERATIVE DIAMETERS OF RADIAL ARTERY, CEPHALIC VEIN, BRACIAL ARTERY AND BASILAR VEIN SIZE:

	CORRELATION BETWEEN PRE OPERATIVE AND INTRA OPERATIVE DIAMETER		
	PRE OPERATIVE DIAMETER IN mm (USG DOPPLER)	INTRA OPERATIVE DIAMETER IN mm by micrometer caliper	p-value
Radial artery size	2.533	2.561	0.0058*
Cephalic vein size	2.621	2.794	0.0001*
Brachial artery size	3.213	2.744	0.0317*
Basilar vein	3.133	3.417	0.0717

*P<0.05

GRAPH 9: CORRELATION BETWEEN PRE OPERATIVE AND INTRA OPERATIVE DIAMETERS OF RADIAL ARTERY, CEPHALIC VEIN, BRACIAL ARTERY AND BASILAR VEIN SIZE:

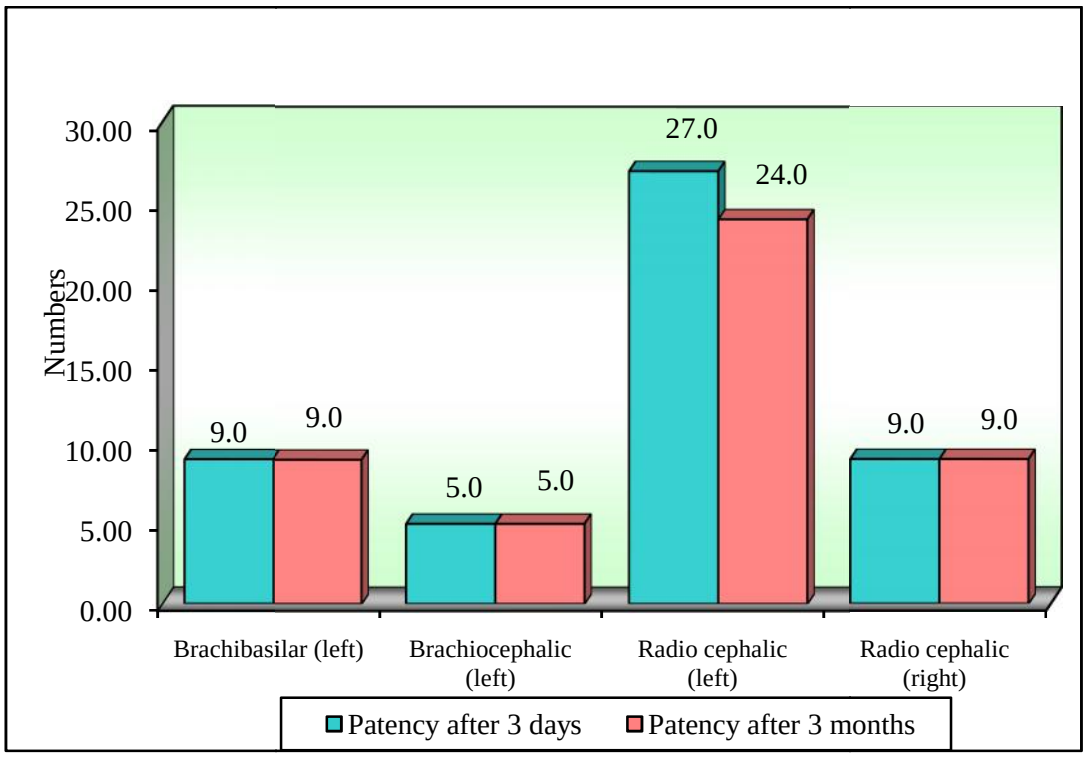


In present study mean preoperative diameter measured by ultrasound Doppler radial artery diameter was 2.533mm, brachial artery 3.213mm, cephalic vein 2.621mm, basilic vein 3.133mm and mean intraoperative diameter measured by micrometer caliper of radial artery was 2.561mm, cephalic vein was 2.7794mm, bracial artery was 2.744mm and basilar artery was 3.417mm.

TABLE 4.9: PRIMARY PATENCY RATE AFTER 3 DAYS AND 3 MONTHS:

	PATENCY AFTER 3 DAYS	PATENCY AFTER 3 MONTHS
Brachibasilar (left)	9 (100%)	9 (100%)
Brachiocephalic (left)	5 (100%)	5 (100%)
Radio cephalic (left)	27 (100%)	24 (88%)
Radiocephlic (right)	9 (100%)	9 (100 %)

GRAPH 10: PRIMARY PATENCY RATE AFTER 3 DAYS AND 3 MONTHS:

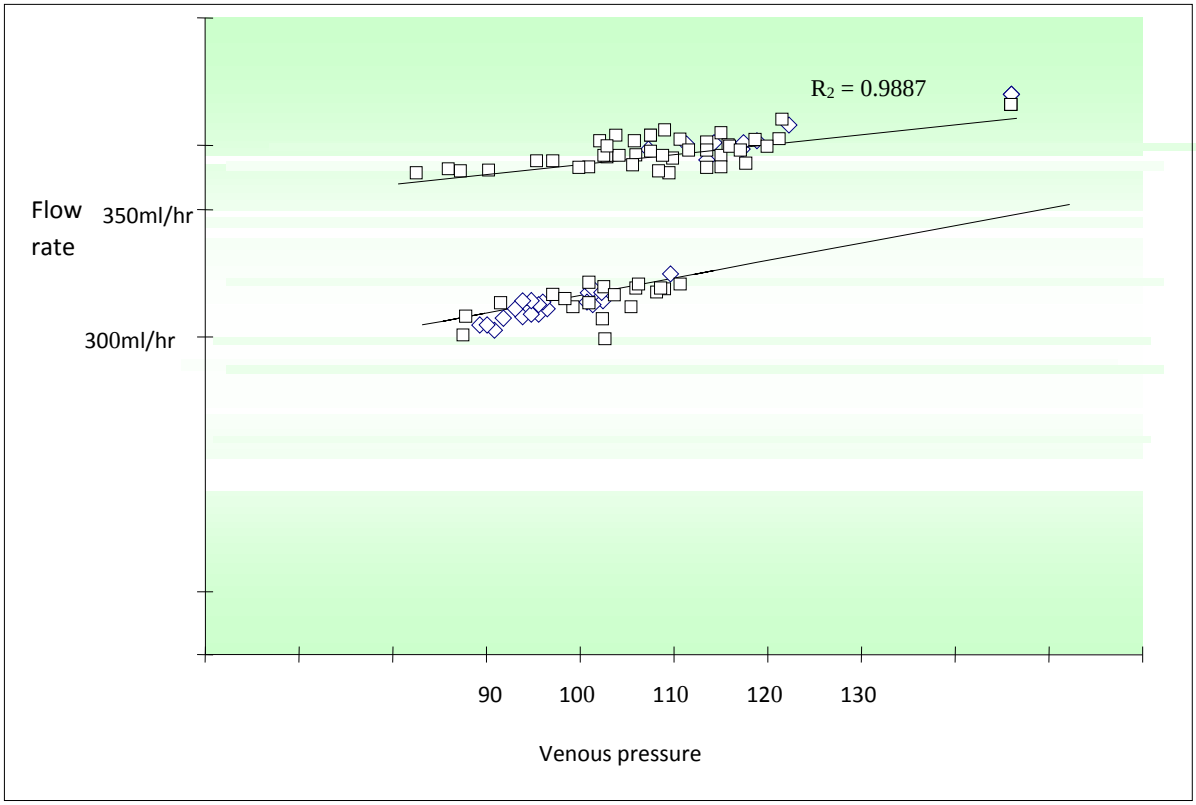


Primary patency rate at 3rd day was 100% and at 3 months was 88%.

Table 4.10:ASSESSMENT OF PATENCY OF FISTULA AT END OF 3 MONTH BASED ON VENOUS PRESSURE AND FLOW RATE:

Type of fistula	Venous pressure at flow rate of 300ml/hr	Venous pressure at flow rate of 350ml/hr
Radiocephalic	90	110
Brachiocephalic	90	110
brachiobasilar	100	120

GRAPH 11: ASSESSMENT OF PATENCY OF FISTULA AT END OF 3 MONTH BASED ON VENOUS PRESSURE AND FLOW RATE:



DISCUSSION

The present study is a one year prospective study conducted from January 2015 to December 2015 in the Department of Medicine and Nephrology, KLES Dr. Prabhakar Kore Hospital and Medical Research Centre, Belagavi.

Total 50 stage 4 to stage 5, CKD patients underwent pre-operative vascular mapping for access placement.

In a study conducted by Allon et al[53], Nonnast Daniel et al[10] and Brimbel et al[59] showed 62% were more then 65 years of age and 58 % were less then 65 years , 55% were in age group of 60 to 70 years and 30% were in the age group of 50 to 60 years ,70%were more than 60 years of age 30% were less than 60 years of age respectively. In our study 40% patients were in the age group of 60 to 70 yrs , 32% were in age group of 50 -60yrs,18% patients were less the 40 years and 10% were in age group of 40-50.Younger patients are developing CKD and are requiring dialysis in our study.

In a study conducted by kaushal et al[72], Wellen et al [61] and Tonneli et al [29] showed 56% ,60%, 70% were male and 44%, 40% and 30% were females respectively. In our study we found that 56% were male and 44% were females.

In a study conducted by Allon et al [53] and Ilhan et al [64] showed diabetic 74% and 60% respectively. In our study 70% were of DM, followed by hypertension (16%), IHD with diabetes were 8% and other diseases (6%).

In a study conducted by Dekhaiya et al [73] and Nursal et al[59] had 62% and 52% radiocephalic fistula and 17% and 26% had brachiocephalic fistula respectively. In our study 54% radiocephalic and 18% brachiocephalic fistula.

In a study conducted by Malvroh et al[57] and Allon et al[34] showed 0 % and 11% negative surgical exploration rate, where preoperative ultrasound Doppler was done prior to surgery. In our study there was reduction in negative surgical exploration rate by 18 %. Pre operative Doppler helps to reduce negative surgical exploration rate.

In a study conducted by Asif et al[33] showed 25% of diabetic patients had brachiobasilar fistula. In our study among 35 diabetic patients,45% underwent radiocephalic fistula (left hand),25% underwent brachiobasilar (left hand),14% brachiocephalic (left hand) and 14% underwent radiocephalic fistula (right hand) in view of inadequate size of vessels due to atherosclerosis.

In a study conducted by Ferring et al[45] showed 20% of hypertensive patients had radiocephalic fistula . In our study 18% underwent radiocephalic fistula (left hand) and 33%, underwent radiocephalic fistula (right hand).

In a study conducted by kaushal et al [36] showed mean radial artery diameter was 2.37mm, bracial artery was 3.13mm, cephalic vein was 3.2mm and basilar vein was 2.16mm. In our study we found that mean radial artery diameter was 2.5mm, ulnar artery 2.4mm, bracial artery 3.2mm, radial vein 2mm, ulnar vein 1.7mm, cephalic vein 2.6mm, basilic vein 3.25mm, bracial vein 3.2mm.

In a study conducted by Srinanth et al[44] showed mean brachial artery size measured surgically was 4.17mm, radial artery was 2.6. mean basilar vein size was 2.3 and cephalic 2.02mm. In our study mean value of radial artery was 2.5mm,

cephalic vein was 2.77mm, bracial artery was 2.74mm and basilar artery was 3.41mm.

This study also showed that there was 95% correlation between the ultrasound and surgical findings for access placement. In our study we found that there was significant co-relation between ultrasound and surgery findings for radial artery (p=0.0058), cephalic vein(p=0.0001), bracial artery(p=0.03) and there was no significant correlation found for basilar vein (p=0.007). This lack of correlation might be due to anatomical variation.

In a study conducted by Shemesh et al[54] showed the primary patency rate at end of 6 months was 79%. In our study primary patency rate at 3rd day was 100% and at end of 3 month was 88% .

In a study conducted by Parag sahasrabudhe et al[74] showed venous pressure of 80 at flow rate of 300ml per minute at end of 6 months .In our study mean venous pressure at 300ml was 90 in radiocephalic fistula, 90 at brachiocephalic and 100 at brachiobasilar and venous pressure at 350ml was 110 at radiocephalic fistula,110 at brachicephalic fistula and 120 at brachiobasilar fistula.

CONCLUSION

- Preoperative sonographic vascular mapping prior to haemodialysis access placement helps to facilitate definite selection of potential sites.
- Maximises the placement of native AV Fistula.
- Helps in reducing incidence of negative surgical exploration and increases the patency rate.
- This facilitates long survival of vascular access.

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ANNEXURE – I - INFORMED CONSENT FORM

CONSENT FOR PARTICIPATION IN RESEARCH STUDY

Mr/Mrs/Miss. _____ we are requesting you to enrol yourself in study titled **"A PROSPECTIVE STUDY OF OUTCOME OF ARTERIOVENOUS FISTULA BY PRIOR ASSESSMENT OF VASCULAR DIMENSIONS IN KLE'S Dr. PRABHAKAR KORE CHARITABLE HOSPITAL, BELGAUM** conducted by Department of General Medicine, J.N. Medical College, Belgaum under KLE university, Belgaum.

Respected Sir/Madam We request you to enroll yourself to participate in our study as you are eligible for participating in the study. During the study you will be asked some questions regarding your present complaint and you are supposed to answer to the best of your knowledge.

Your participation in this research is voluntary. Your decision whether or not to participate in the study will not affect your relationship with J.N.Medical College. If you decide to participate you are free to withdraw at any time.

The purpose of research is to know outcome of arteriovenous fistula by prior assessment of vascular dimensions.

Purpose of the study:

There have been many studies comparing the efficacy and safety of the numerous access techniques although meta-reviews of these have turned out to be inconclusive, warranting the need for further evidence.

No study has been in our institution comparing these two techniques. Thus, no local, evidence-based guidelines can be formulated.

In view of the mentioned confusions and the paucity of literature there is a need for local guidelines to be drafted.

This study is conducted to compare the safety and efficacy of the Hasson cannula and Veress needle techniques for gaining entry and establishing pneumoperitoneum.

Procedure Involved:

If you agree to enrol yourself in my study, I will ask your present past and family history. Then you will be clinically examined in detail and routine investigations like Hb, TC, DC, Platelet Count, RBS, Blood Urea, Serum Creatinine, Blood Grouping, Chest X-ray, USG doppler, ECG, will be done accordingly. You will be allotted into one of the two groups randomly using sequential numbered brown opaque envelop method.

The ultrasonographic result will then be correlated with per-operative size of the vessel used, surgical procedure and outcome. Correlation will be performed to determine the selection of access site. The discrepencies found between the US and operative findings will also be evaluated. Sizes of the vessel used for fistula formation will be noted and measured. The diameter of the vessel selectedwill be measured with the help of a micrometer caliper.

Followup of the patients was done at 3rd day and at the end of three months to assess the flowrate and patency of fistula.

Risks: There is no risk associated with study.

Benefits: Preoperative sonographic vascular mapping prior to haemodialysis access placement helps to facilitate definite selection of potential sites.

Voluntary Participation/Withdrawal:

Taking part in the study is voluntary. You may choose not to enrol yourself in this study. Your decision will not change present or future health care services offered to you at K.L.E. hospital.

Alternatives:

Even if you decline the participation in the study, you will get the routine line of management.

Privacy and Confidentiality:

The only people to know that you are a research subject are members of the research team. No information about you or information provided by you during the research will be disclosed to other without your written permission except:

1. In emergency to protect your rights and welfare.

2. If required by law.

Authorization to Publish Results:

When the results of the research are published or discussed, in a conference, no information will be displayed that would disclose your identity. Any information

that is obtained in connection with this study and that can be identified with your identity remaining confidential.

Financial Incentives for participation:

No financial incentives are being offered to enrolled patients. It is purely being done with the idea of research and all the cost of the study will be borne by the investigator.

Compensation:

In the event of injury related to the study, treatment will be made available through KLES' Hospital &MRC, Belgaum. There is no compensation or payment for such medical treatment by law. If you are injured you may contact .

Questions:

In case you have any questions related to the study, in future or in case of study related injury or illness, you can contact

If you have any queries about your rights as a study subject, you may call

Dr. Ganga Pilli,
Professor, Department of Pathology and Chairman,
J.N. Medical College Institutional Ethical Committee for Human Subjects Research,
Phone number- 9448863866

", A PROSPECTIVE STUDY OF OUTCOME OF ARTERIOVENOUS FISTULA BY PRIOR ASSESSMENT OF VASCULAR DIMENSIONS IN KLE'S DR. PRABHAKAR KORE CHARITABLE HOSPITAL, BELGAUM.

Consent for participation in research trial

I, Mr/Ms/Mrs. _____ voluntarily agree for the participation as a subject of study. By signing this consent form I am not giving up any of my legal rights, I may withdraw from the study anytime. I am signing the consent form after having read or been read for me in vernacular language, including the risks and the benefits and having all my questions answered.

Subject Name : _____

Signature or the Left Thumb Print of Subject :_____

Date :

Witness Name : _____ Signature:_____

Investigators Name: _____ Signature:_____

Guide: Dr.M.S.Khanpet

Signature: _____

Date :

Place : _____

ANNEXURE – II - PROFORMA

PROFORMA

"A PROSPECTIVE STUDY OF OUTCOME OF ARTERIOVENOUS FISTULA BY PRIOR ASSESSMENT OF VASCULAR DIMENSIONS, IN KLE'S DR. PRABHAKAR KORE CHARITABLE HOSPITAL, BELGAUM.

Name: _____

Address_____

Age:____

IP. No: _____

Sex:

DOA:

Chief Complaints:

Previous history of access placement :

History of temporary dialysis:

GENERAL PHYSICAL EXAMINATION:
PALLOR:

ICTERUS:

CYANOSIS:

CLUBBING:

LYMPHADENOPATHY:

EDEMA:

VITALS:
PR: BP:

SYSTEMIC EXAMINATION:

CVS:

RS:

PA:

CNS

ULTRA SOUND FINDINGS

ARTERIES:

Arteries	**Diameter (in mm)**	**Velocity (cms/sec)**	**Distance from skin in cm**	**comments**
Radial (at wrist)				
Ulnar (at wrist)				
Brachial (at cubital)				

VEINS:

Veins	**Diameter (in mm)**	**Distance from skin in cm**	**comments**
Radial			
Ulnar			
Cephalic			
Basilar			
Bracial			

OPERATIVE FINDINGS:

Artery	Diameter (In mm)	Vein	Diameter (In mm)
Radial (at wrist)		Radial	
Ulnar (at wrist)		Ulnar	
Brachial (at cubital)		Cephalic	
		Basilar	
		Bracial	

Type of surgery done:

Outcome Of Fistula:

Patency:

Flow Rate:

Venous Pressure: