AIM

Aim of the study :

To assess the maturation time, usability, longevity of the autogenous AV access with reference to pre operative arterial and venous diameter with duplex mapping and a post operative evaluation of flow rates, maturity of AV acess by duplex ultra sonography

Study area and the rationale:

Duplex USG is the most commonly used tool to identify hemodialysis access dysfunction. Although angiography is the recognized gold standard, ultrasound has the advantage of being non-invasive and providing anatomic and physiologic information. The use of ultrasound is supported by the K/DOQI guidelines.

Surveillance of access has significant implications on treatment and prevention of access thrombosis. The purpose of this study is early detection of access failure/stenosis. With comparison of the pre and post operative venous diameters with the flow rate.

Material and method:

From july 2008 to july 2010, patients who required chronic hemodialysis underwent segmental upper extremity duplex ultrasound with mapping of arteries and veins. The following criteria were necessary for satisfactory arterial inflow: absence of a pressure gradient between arms, patent palmar arch, and arterial lumen diameter 2.0 mm or more. The criteria necessary for satisfactory venous outflow were venous luminal diameter greater than or equal to 2.5 mm for AF continuity with distal superficial veins in the arm.

Study population:

A total of 67 patients underwent AV Fistula creation at our institute between the period of July 2008 and July 2010, out of them 5 patients were lost for follow up. Hence 62 patients finally formed the study group.
The study was a prospective study.
All patients were examined and the site and type of fistula was decided based on clinical examination.
Doppler ultrasonography was used to access arterial diameter, vein diameter, tributaries and proximal venous patency.
Access blood flow was measured 5cm from the site of anastomosis at one month and at three months after operation.
All patients underwent arterio venous fistula performed under local anaesthesia. Written consent was taken from all the patients.

The patient's history of the potential factors that may complicate the creation of an AVF which includes a record of all the venipunctures and procedures involving the upper and lower extremities, any previous history of thrombosis, and the use of central venous catheters were all recorded. The hospital staffs (venipuncture teams, nurses etc) were all instructed on how to manage these patients to avoid unnecessary use of upper arms veins and patients should be thought to preserve integrity of their veins by refusing needle sticks by lab and nursing personnel on the selected limb.

Arterial Examination:

Radial pulse was examined in all patients. Ulnar Artery (medial in the flexor surface of the wrist) and the brachial Artery (medial to biceps brachii tendon) were also examined.

Allen Test:

The ulnar artery is sometimes difficult to palpate, hence Allen test were done to check for patency.

Venous Examination:

A tourniquet was placed on the upper portion of the arm. The patients were asked t to close and open repeatedly the hand to increase venous engorgement. The cephalic and basilic vein in the arm, antecubital area and forearm were also assessed.

Procedure of choice in vascular access surgery:

We considered the following general guidelines before access placement

-Selection of the non dominant arm (if possible)

-Placement of the access distally to preserve proximal sites

-Avoiding atherosclerotic arteries

-The selected veins should have a long segment to allow for variation in puncture sites.

Imaging Interpretation:

All patients underwent doppler ultrasonography of the selected limb in the radiology department using high-resolution gray scale and color Doppler sonography. The patients were examined with a 10 MHz linear probe at an incidence angle of 60 degrees in the supine positions during rest and after applying a tourniquet to assess the distensibility of veins. The cephalic vein and its tributaries were recorded to note the caliber of the veins, also the proximal draining veins such as subclavian, Brachiocephalic and also the basilic, axillary, external jugular and internal jugular veins were checked. All measurements made by same observer. Internal diameter of artery measured by B-mode ultrsonography.

Procedure:

AV Fistula was constructed under local anaesthesia.
A longitudinal incision proximal to styloid process was placed in creation of radiocephalic AVF.
A transverse incision was placed just below the cubital crease for performing a brachiocephalic AV Fistula. The vein and artery were dissected and brought together to lie side by side. All patients underwent end to side anastomosis .

Follow up care:

Our immediate postoperative care protocol were as follows
-The patient should be monitored
-Examination Inspection: Presence of a haematoma/ bleeding from the operated site
Palpation: Thrill suggesting working status of the fistula
Auscultation: Measure the maximum distance that the bruit is heard in the forearm and arm
-If stable discharge the patient after 4 hours
-The patient will receive instructions to call us or to return to the hospital:
Bleeding from the AVF

US Mapping Technique

The preoperative diameter criteria used for adequate upper extremity surgical results at our institution are (*a*) all arteries 2.0 mm or larger and (*b*) all veins, both in the forearm and upper arm, 2.5 mm or larger for AVF creation, or veins 4.0 mm or larger for graft creation (6). Anteroposterior vessel diameters are measured in the transverse plane, with a minimum amount of pressure on the vessel.

Forearm Mapping

The patient's arm is comfortably positioned at approximately 45° from the body, with the elbow resting on a Mayo stand. Antegrade radial arterial flow is documented at the wrist level, and the radial arterial diameter is measured. If the radial arterial diameter is less than 2.0 mm, the ulnar arterial diameter is measured at the wrist. If neither the radial nor ulnar artery is 2.0 mm or larger, the arteries are not suitable for forearm AVF creation. In this case, the upper arm is then assessed as detailed in the next section.

A tourniquet is placed at the middle forearm, assuming that an adequate radial or ulnar artery is identified as previously described. The entire distal forearm is percussed for 2–3 minutes, similarly to the percussion maneuvers performed prior to intravenous placement, with special attention given to the cephalic vein and the other dorsal forearm veins.

The cephalic vein diameter at the wrist is measured. If the diameter is 2.5 mm or larger, the cephalic vein is followed toward the elbow. The diameter and location of cephalic vein branches in the forearm that are larger than 1.0 mm are recorded. The tourniquet is then sequentially placed in the antecubital area and cranial upper arm, and the cephalic vein is followed to its insertion into the subclavian vein. A forearm cephalic vein AVF is still possible if the cephalic vein is occluded or smaller than 2.5 mm in the upper arm, as long as the forearm cephalic vein drains into an acceptably sized forearm median cubital vein and brachial or basilic vein (to the subclavian vein).

If the cephalic vein diameter at any point in the forearm or upper arm is less than 2.5 mm, the dorsal and volar regions of the forearm are searched for other veins. If a suitable vein is found, a transposition AVF may be possible. The draining vein is assessed for stenosis or occlusion in the upper arm.

Upper Arm Mapping

If no suitable forearm vein is found, the brachial arterial diameter is measured at the antecubital space. A tourniquet is placed near the axilla, and the cephalic, basilic, and brachial veins from the antecubital area to the cranial aspect of the upper arm are examined. No percussion maneuvers are performed in the upper arm, because we have found that they are not helpful in vein distension. Veins of acceptable diameter are followed into the subclavian vein to assess for stenosis or occlusion by using visual inspection and compression techniques.

Draining Veins

All draining veins are assessed for stenosis and thrombosis throughout their course with visual inspection and compression. Adequate vein diameter is confirmed into the deep veins. Drainage into the deep venous system is confirmed with color Doppler imaging.

Indirect Assessment of Central Veins

Subclavian and jugular venous Doppler waveforms are analyzed for indirect evidence of central venous abnormality. Indirect evidence of stenosis or occlusion in the nonvisualized brachiocephalic vein and/or superior vena cava include diminished respiratory phasicity and diminished transmitted cardiac pulsatility in the subclavian and jugular veins (7–9]. If diminished respiratory phasicity is found, we perform Valsalva and sniff maneuvers to determine whether flow drops to the baseline. If one side—either the right or left—is abnormal, the contralateral side is examined to assess for abnormal waveforms.

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 (Table):

Hemodialysis Access Placement in Preferential Order, from Most to Least Desirable

Access Placement Type	Description of Access Placement
Note.—The nondominant arm is the preferred site for access placement. However, AVF placement is preferable to graft placement, even if it means placing an AVF in the dominant arm rather than a graft in the nondominant arm.	
* Transposition AVFs are placed in veins other than the cephalic vein. The vein is dissected out and tunneled subcutaneously in a position convenient for hemodialysis access.	
Forearm AVF	Radial artery to cephalic vein or radial artery to basilic or other suitable forearm vein (transposition*)
Upper arm AVF	Brachial artery to cephalic vein or brachial artery to basilic or other suitable upper arm vein (transposition*)
Forearm graft	Brachial artery and antecubital vein, a "loop" graft
Upper arm graft	Brachial artery and high brachial or basilic vein, a "straight" graft
Thigh graft	Common femoral artery to common femoral vein

Determination of Clinical Outcome

Determination of fistula maturity was made clinically by the nephrologists and hemodialysis nurses. A fistula was deemed adequate for dialysis if it could be cannulated with 2 needles and allowed a dialysis blood flow of 350 mL/min or greater in at least 6 sessions during 1 month.[5] Primary fistula failures were classified as "early thrombosis" if they clotted within 12 weeks of placement and as "failure to mature" if they were patent but still not adequate for hemodialysis within 6 months of their placement. Fistula outcome was deemed indeterminate if the patient died, was transferred to an outside unit, or was switched to peritoneal dialysis before fistula adequacy for hemodialysis could be determined or if the patient had not yet started dialysis at the time of data analysis.

Fistula adequacy was defined prospectively as the ability to sustain hemodialysis with two needles and a blood of at least 350mL/min on at least six dialysis sessions assisted in one month [14]. A fistula was considered inadequate Access for dialysis if it (*1*) clotted before it could be used, (*2*) was still not useable for dialysis six months after its construction, or (*3*) was converted electively to an AV graft prior to being used for dialysis. Fistula adequacy was deemed indeterminate if the patient died, received a kidney trans- plant, or was lost to follow-up before the fistula could mature. Primary access (fistula or graft) failure was defined as an access that never achieved adequacy for dialysis

RESULTS

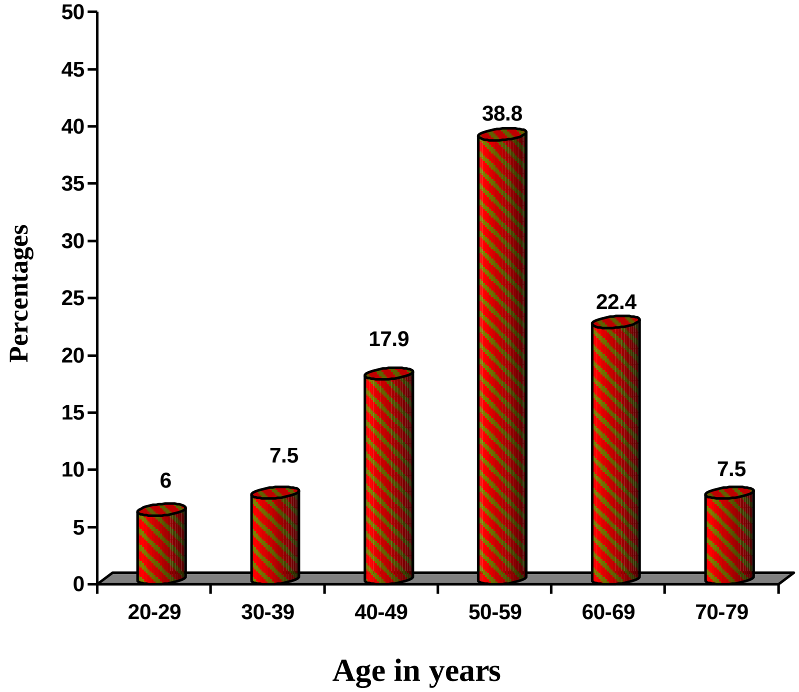
Study design:

A Prospective non-controlled surgical study with 67 patients is undertaken to study the pre-operative arterial and venous diameter measurement for autogenous hemodialysis AV access with duplex mapping.

Table 1: Age distribution of patients studied

Age in years	Number of patients	%
20-29	4	6.0
30-39	5	7.5
40-49	12	17.9
50-59	26	38.8
60-69	15	22.4
70-79	5	7.5
Total	67	100.0

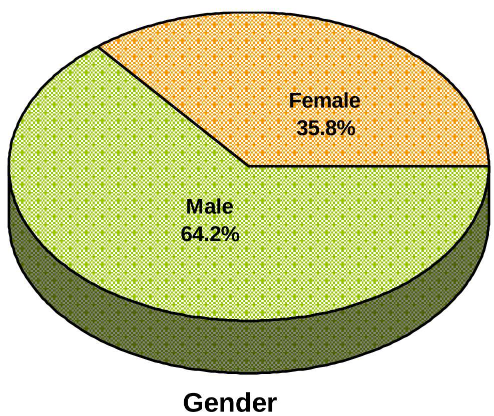
Mean ± SD: 53.04±12.51



In age distribution maximum numbers of patients were in the age group of 50-59 years i.e., 38.8% and least number of patients were in 20-29 age groups i.e., 6.0%. Another 7.5% of patient s were of 30-39 and 70-79 age group.

Table 2: Gender distribution of patients studied

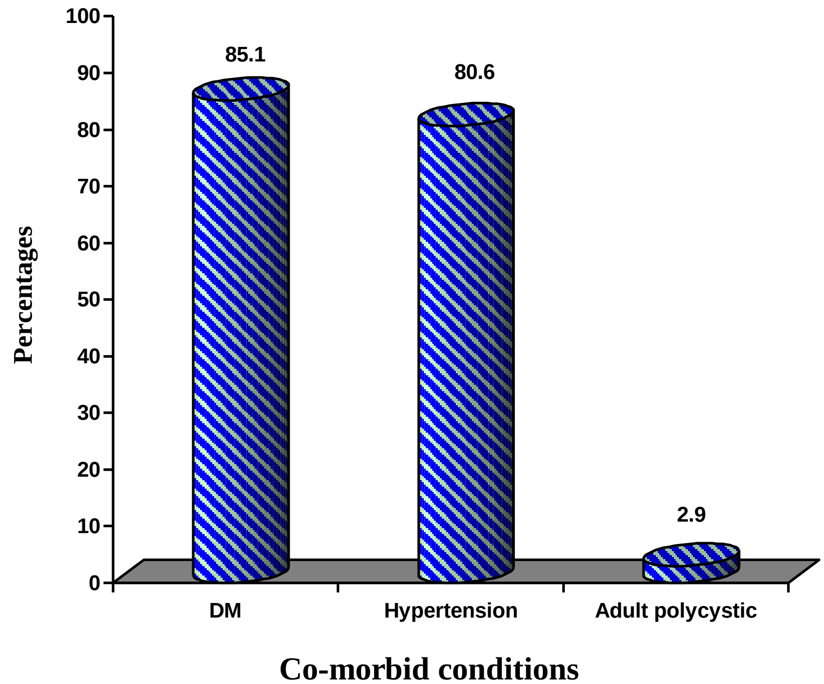
Gender	Number of patients	%
Male	43	64.2
Female	24	35.8
Total	67	100.0



In gender distribution the male patient (64.2%) were more than female (35.8%)

Table 3: Co-morbid conditions

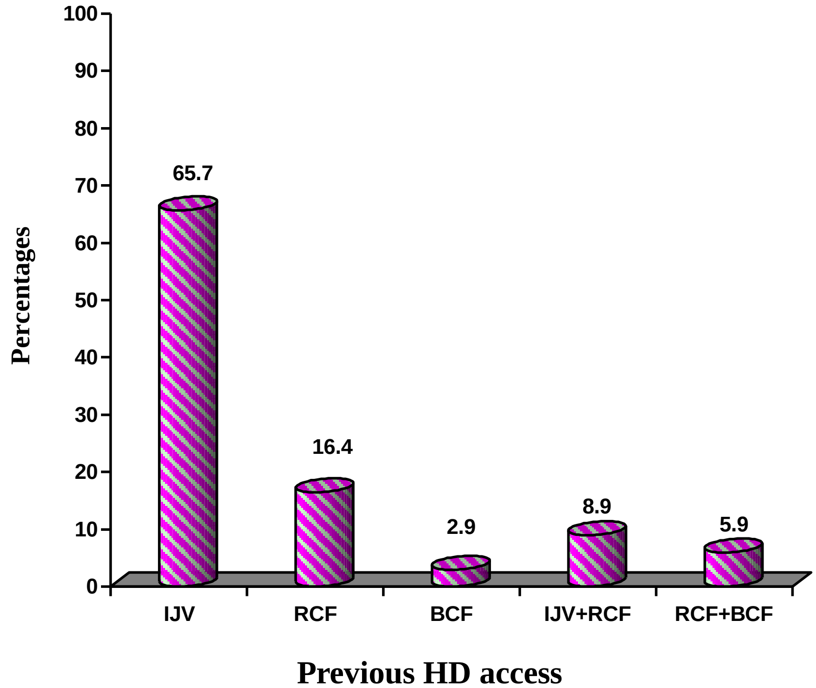
Co-morbid conditions	**Number of patients (n=67)**	**%**
DM	57	85.1
Hypertension	54	80.6
Adult Polycystic	2	2.9



Maximum number of patients (85.1%) had diabetes mellitus as comorbid condition with hypertension (80.6%) as the second comorbility only 2.9% of patient had adult polycystic kidney disease

Table 4: Previous HD access

Previous HD access	Number of patients (n=67)	%
IJV	44	65.7
RCF	11	16.4
BCF	2	2.9
IJV+RCF	6	8.9
RCF+BCF	4	5.9

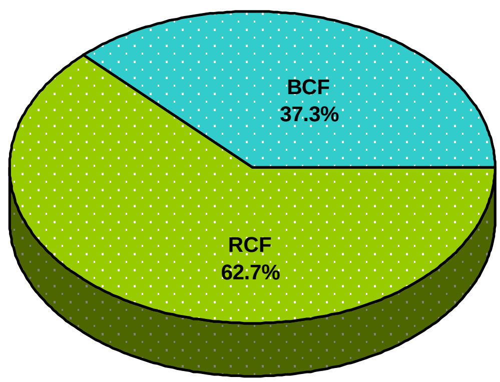


IJV access was the highest (65.7%) mode of haemodialysis access ,the patients presented with . RCF (16.4%) was the second highest mode of previuos haemodialysis access. i.e., earlier failed access.

All the patients referred for an access were already on dialysis. None were referred earlier. i.e., before the patient had become dialysis dependent.

Table 5: Procedure

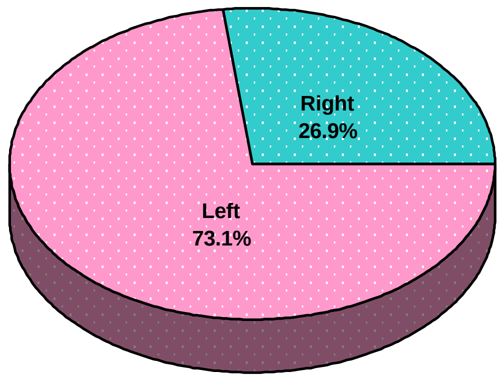
Procedure	**Number of patients (n=67)**	**%**
RCF	42	62.7
BCF	25	37.3



Maximum number (62.7%) patients underwent RCF and only 37.3% of patient underwent BCF

Table 6 Side involved

Side	**Number of patients (n=67)**	**%**
Left	49	73.1
Right	18	26.9

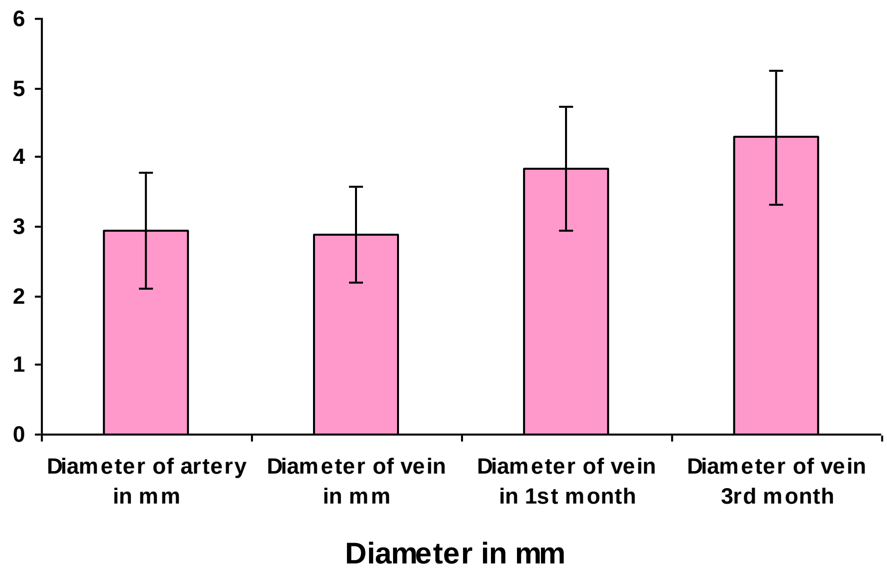


Side

73% of patients had their fistulas done on left side and only 26.9% of patients underwent fistula creation on right side

Table 7: descriptive statistics variables studied

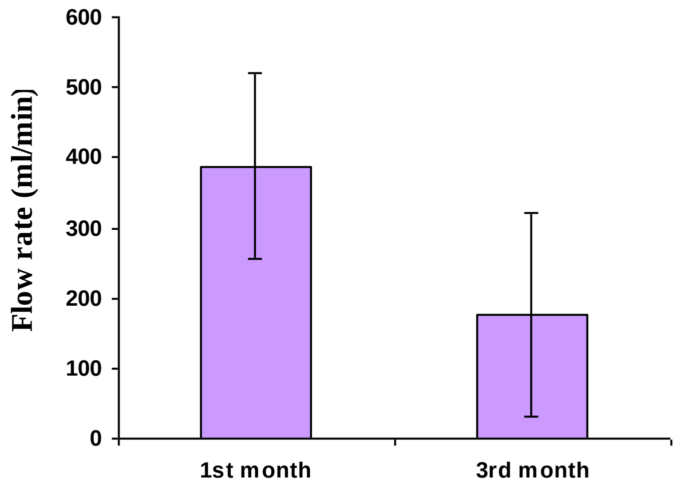
Diameter in mm	**Min-Max**	**Mean ± SD**
Diameter of artery in mm	1.60-5.10	2.94±0.84
Diameter of vein in mm	2.0-5.50	2.88±0.69
Diameter of vein in 1st month	2.60-6.80	3.83±0.89
Diameter of vein 3rd month	2.60-7.00	4.29±0.96



Average diameter of artery In mm was 2.94 (SD: 0.84) and vein was 2.88 (SD:0.69) pre operatively. The average diameter of vein was increased to in first month increased 3.83 (SD:0.89) and in 3rd month 4.29 (SD:0.96). The arterial diameters were ranging from 1.60 to 5.10 mms and the venous diameters from 2.0 to 5.50mm preoperatively. The venous diameters ranged from 2.60 to 6.80 in first month and 2.60 to 7.0 mm in 3rd month.

Table 8: Descriptive statistics variables studied

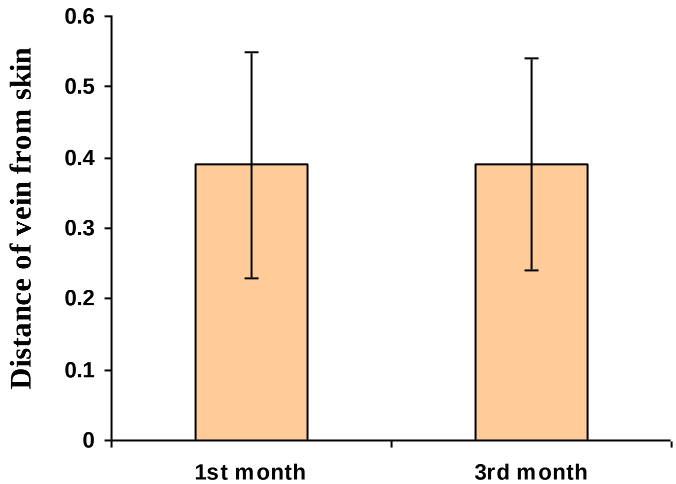
Flow rate (ml/min)	Min-Max	Mean ± SD
1st month	214.0-789.0	387.42±131.58
3rd month	176.0-893.0	444.84±145.82



The flow rates (ml/min) in vein was average of 387.42 (SD:131.58) in first month with a range of 214.0 to 789.0 (ml/min).
The average flow rates(ml/min) in 3rd month was 444.84 (SD:145.82) with a range of 176.0 to 893.0 ml/min.
This shows that the flow rates improved from first month to 3rd month.

Table 9: Descriptive statistics of distance of vein from skin

Distance of vein from skin	Min-Max	Mean ± SD
1st month	0.18-0.76	0.39±0.16
3rd month	0.18-0.81	0.39±0.15



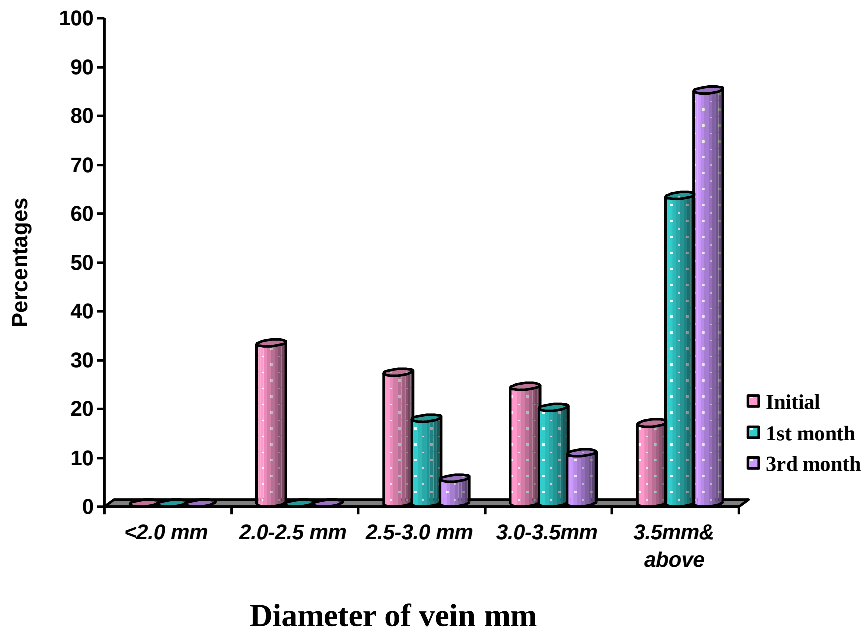
The minimum distance of vein from the skin (in cms) at 1st month was 0.39 (SD:0.16) the range being 0.18 to 0.76 cms

The distance of vein (in cms) from skin at 3rd month was also 0.39 (SD:0.75) the range being 0.18 to 0.81

This indicated that the maturation indicator of venous distance from skin achieved at the initial month only

Table 10: Diameter of vein in mm

Diameter of vein mm	Initial	1st month	3rd month
<2.0 mm	0	0	0
2.0-2.5 mm	22(32.8%)	0	0
2.5 -3.0 mm	18(26.8%)	8(17.4%)	2(5.1%)
3.0-3.5mm	16(23.9%)	9(19.6%)	4(10.3%)
3.5 mm & above	11(16.4%)	29(63.0%)	33(84.6%)
Total	67(100.0%)	46(100.0%)	39(100.0%)
Mean ± SD	**2.88±0.69**	**3.83±0.89**	**4.29±0.96**
P value (from Initial)	**-**	**<0.001****	**<0.001****



The patient with <2.0 vein diameter were not taken into study
59.6% of patients had venous diameter between 2-3mms preoperatively
About 40% of patients had venous diameters between 3.0mm and above
At first month the only 17.4% of patients had venous diameter between 2-3 ms

There was significant increase in number of patients with diameters between 3mm and above i.e. 82%.
At 3rd month the venous diameter of patients between 2 to 3mm was only 5.1% & the percentage of patients with venous diameters between 3mm and above had increased to 94.9% at 3rd month.
The mean diameter of vein preoperatively was 2.88 (SD 0.69) had improved to 3.83 (SD: 0.89) at 1st month , further improved to 4.29 (SD:0.96) at 3rd month which was statistically significant (P-<0.001)

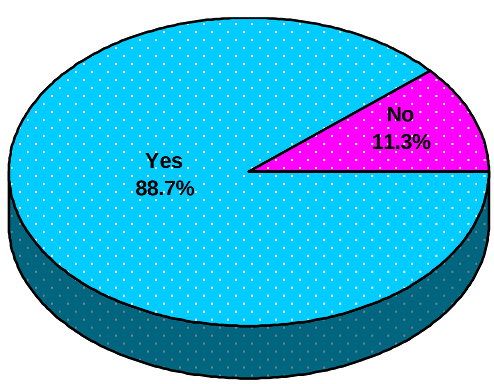
Table 11: Outcome

Outcome	**Number of patients (n=62)**	**%**
Functional patency	39	62.9
Failures	23	37.1
• Immediate failure	16	25.8
• Early failure	5	8.1
• Primary failure	2	3.2

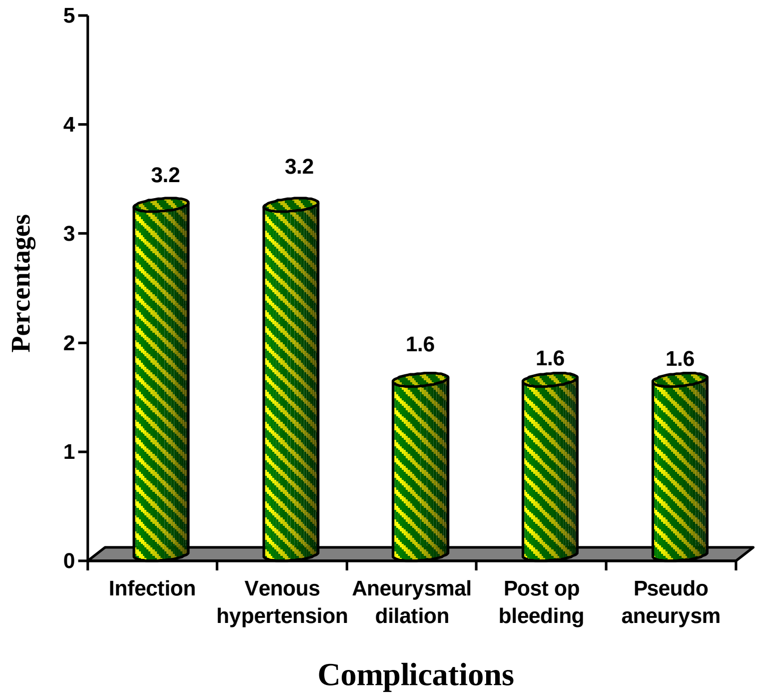
There was functional patency of 62.9% noted with total failures of 37.1%, including immediate, early and primary failures (described earlier).

Table 12: Complications

Complications	**Number of patients (n=62)**	**%**
No	55	88.7
Yes	7	11.3
• Infection	2	3.2
• Venous hypertension	2	3.2
• Aneurysmal dilation	1	1.6
• Post op bleeding	1	1.6
• Pseudo aneurysm	1	1.6



Complications



In our study the complication rate was to only 11.3% including all types. 88.7% of patients did not had any complications during our study period Infection (3.2%) was treated by appropriate antibiotics and observation. Venous hypertension (3.2%) underwent central venous angioplasty and stenting in one patient and angioplasty alone in another patient

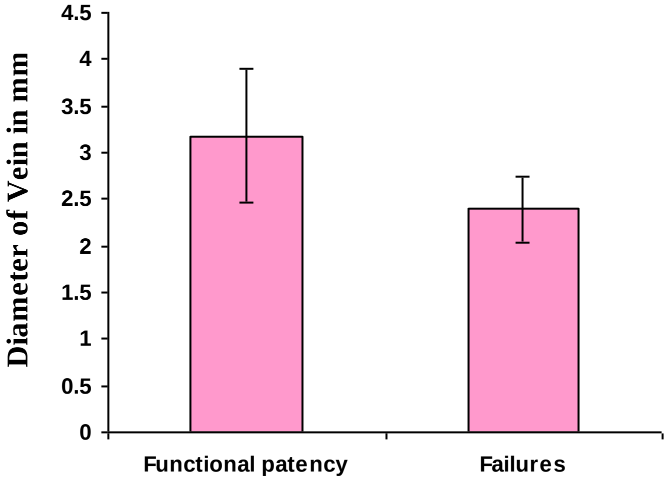
Table 13: Pearson correlation between vein and arterial diameters with flow rate

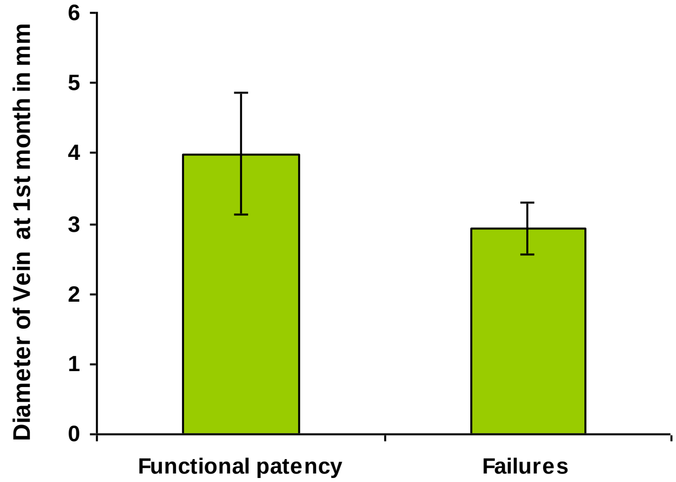
Pair	Pearson correlation	P value
Diameter of Vein in mm vs 1st MONTH FLOW RATES ml/min	0.667	<0.001**
Diameter of Artery in mm vs 1st MONTH FLOW RATES ml/min	0.702	<0.001**
Diameter of Vein in mm vs 3rd MONTH FLOW RATES ml/min	0.586	<0.001***
Diameter of Artery in mm vs 3rd MONTH FLOW RATES ml/min	0.655	<0.001**

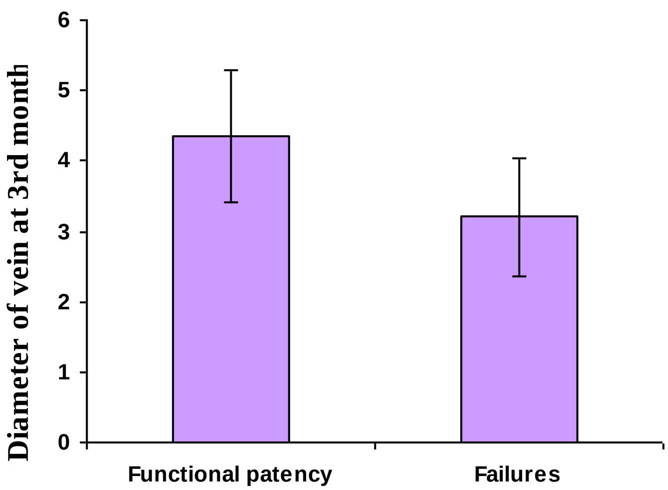
The person correlation between vein and artery with flow rates was performed for first and 3rd month
The correlation between diameter of vein and flow rate at 1st month was observed very large with r=0.702: P<.001
The correlation between diameter of artery and flow rates at 1st month was observed very large with r=0.702; p<0.001.
The correlation between diameter of vein and flow rates at 3rd month was observed large with r=0.586; p <0.001
The correlation between diameter of vein and flow rates at 3rd month was observed large with r=0.655; p<0.001
This indicates that the initially arterial diameter also matters in the flow rates.

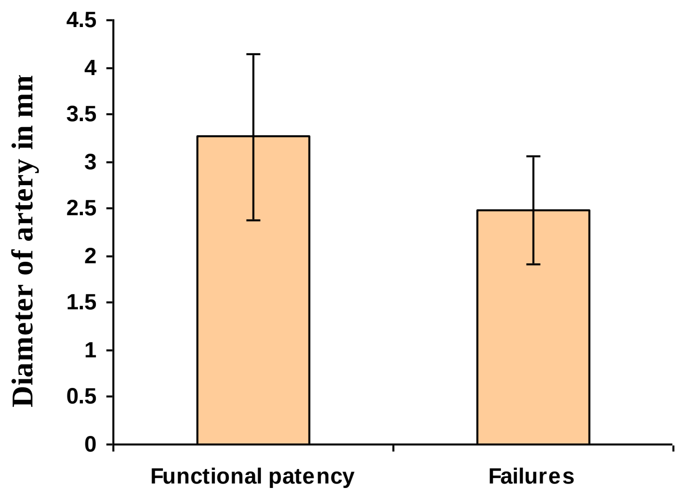
Table 14: Vein and arterial diameter with failures

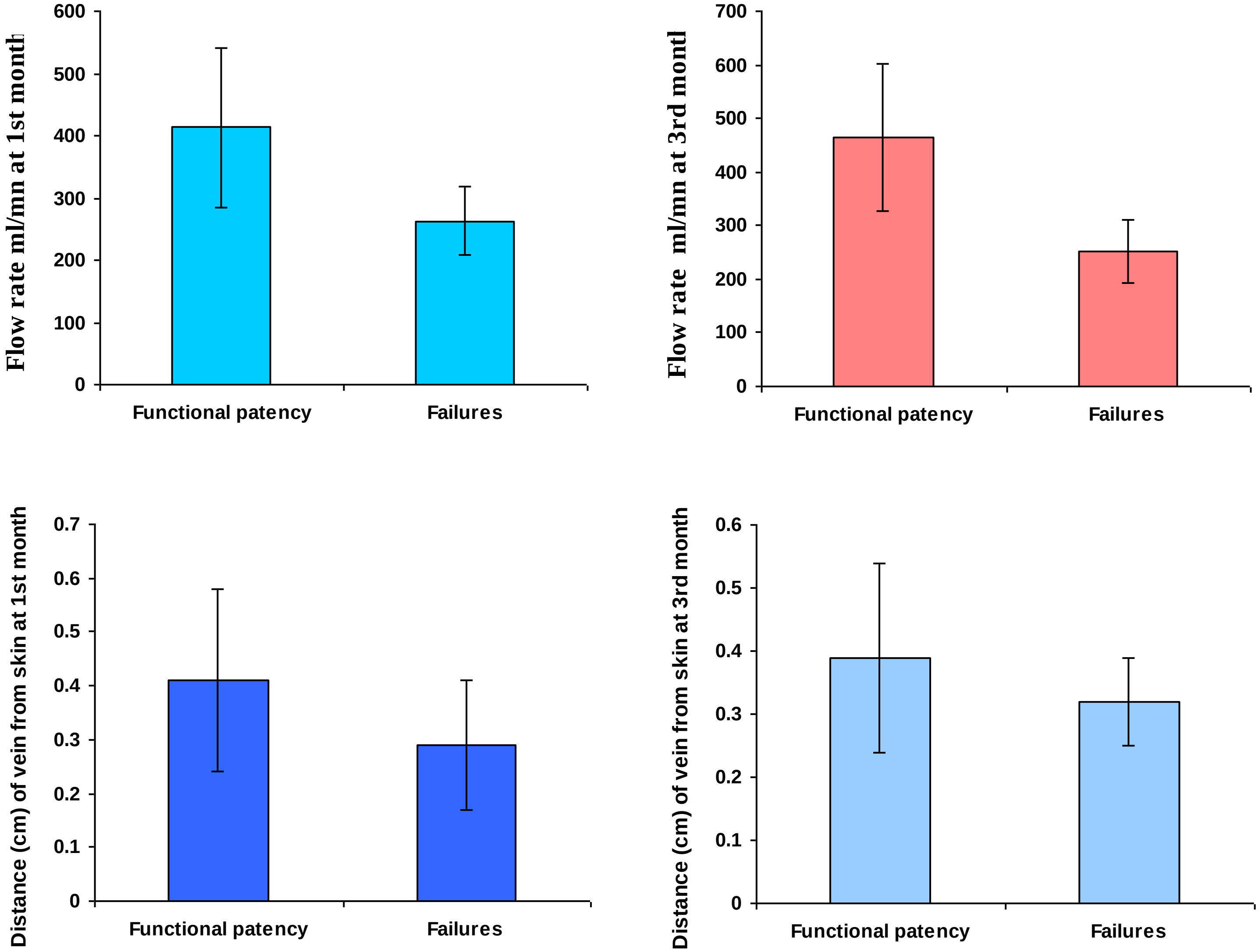
Vein and diameter (mm)	Outcome		
	Functional patency	**Failures**	**P value**
Diameter of Vein in mm	3.18±0.72	2.39±0.36	<0.001**
Diameter of Vein at 1st month in mm	3.99±0.87	2.93±0.38	0.003**
Diameter of vein at 3rd month	4.34±0.94	3.20±0.84	0.100
Diameter of artery in mm	3.26±0.88	2.49±0.57	<0.001**
Flow rate ml/mn at 1st month	412.89±128.49	263.25±54.06	0.002**
Flow rate ml/mn at 3rd month	464.49±137.71	253.25±59.10	0.004**
Distance (cm) of vein from skin at 1st month	0.41±0.17	0.29±0.12	0.053+
Distance (cm) of vein from skin at 3rd month	0.39±0.15	0.32±0.07	0.535


Diameter of Vein in mm
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
Functional patency
Failures


Diameter of Vein at 1st month in mm
6
5
4
3
2
1
0
Functional patency
Failures


Diameter of vein at 3rd month
6
5
4
3
2
1
0
Functional patency
Failures


Diameter of artery in mm
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
Functional patency
Failures


Flow rate ml/mn at 1st mont
600
500
400
300
200
100
0
Functional patency
Failures
Flow rate ml/mn at 3rd mont
700
600
500
400
300
200
100
0
Functional patency
Failures
Distance (cm) of vein from skin at 1st month
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Functional patency
Failures
Distance (cm) of vein from skin at 3rd month
0.6
0.5
0.4
0.3
0.2
0.1
0
Functional patency
Failures

Student ‘t’ test was performed to assess the diameter of vein between functional patency and failures

The diameter of vein was 3.18 (SD:0.72) for functional patency preoperatively and it was 2.39 (SD:0.36) for failures . It was observed that diameter of vein was significantly less in failures, compared to patency ($p<0.001$)

The diameter of vein at 1st month for functional patency was 3.99 (SD:0.87) and 2.93 (SD:0.38) for failures. Again it was observed the diameter of vein was significantly less in failures compared to patency ($p=0.003$)

The diameter of vein at 3rd month for functional patency was 4.34 (SD:0.94) and 3.20 (SD:0.84) for failures. But the diameter was not significantly less in failures compared to patency ($p=0.100$)

The pre operative arterial diameter was 3.26 (SD:0.88) for functional patency and 2.49 (SD:0.57) for failures

It is observed that diameter artery was significantly less in failures compared to patency ($p<0.001$)

The flow rates at first month was mean 412 ml/min (SD 128.49) for patency and 263.25 (SD:54.06) for failures.

This also indicates significantly less flow rates in failures compared to patency (p:0.002)

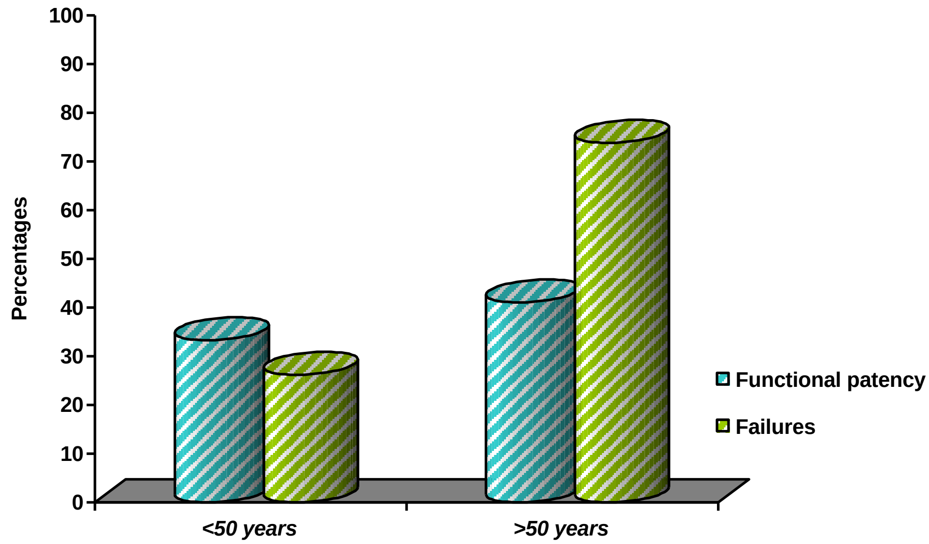
Again flow rates at 3rd month for patency was 464.49 (SD:137.71), compared to failures was 253.25 (SD:59.10), which was also significantly less for failures compared to patency (p:0.004)

The distance of vein (cms) from skin at 1st and 3rd months for patency and failures was 0.41 (SD:0.17), 0.29 (SD 0.12) and 0.39 (SD 0.15), 0.32 (SD 0.07) respectively

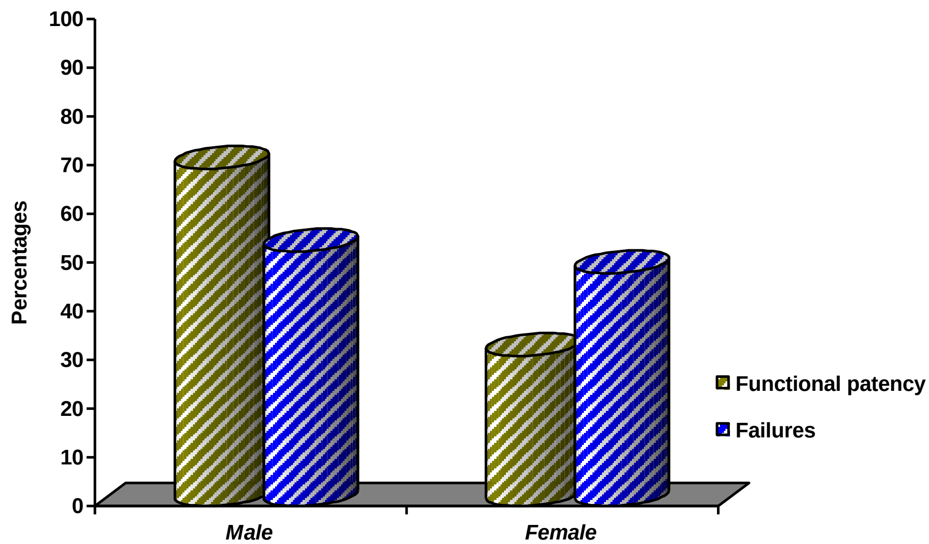
Both of 1st and 3rd month vein distance are not statistically significant (p:0.053) and (p:0.535) respectively.

Table 15: Association of risk factors with incidence of failures

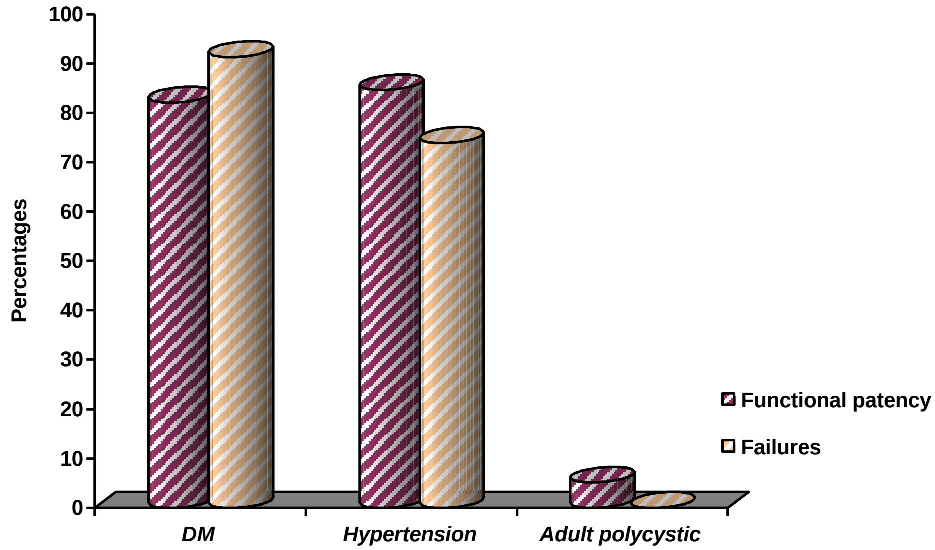
Risk factors	Outcome		P value
	Functional patency (n=39)	Failures (n=23)	
Age in years			
• <50 years	13(33.3%)	6(26.1%)	0.247
• >50 years	16(41.0%)	17(73.9%)	
Gender			
• Male	27(69.2%)	12(52.2%)	0.179
• Female	12(30.8%)	11(47.8%)	
Co-morbid conditions			
• DM	32(82.1%)	21(91.3%)	0.464
• Hypertension	33(84.6%)	17(73.9%)	0.334
• Adult Polycystic	2(5.1%)	0	
Previous HD access			
• IJV	19(48.7%)	21(91.3%)	0.001**
• RCF	8(20.5%)	2(8.7%)	0.298
• BCF	2(5.2%)	0	0.526
• IJV+RCF	6(15.4%)	0	0.076+
• RCF+BCF	4(10.3%)	0	0.287
Procedure			
• RCF	20(51.2%)	3(13.0%)	0.003**
• BCF	19(48.7%)	20(86.9%)	



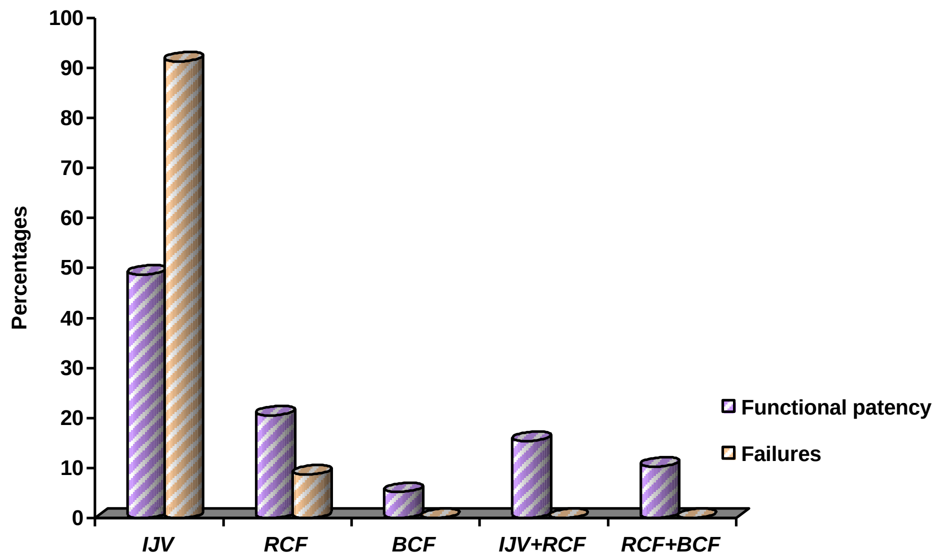
Age in years



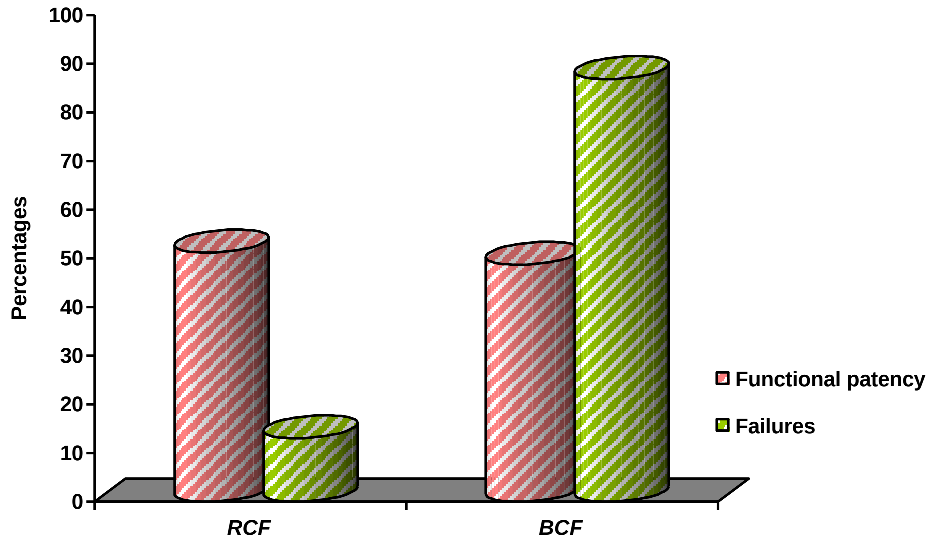
Gender



Co-morbid conditions



Previous HD access



Procedure

The Chi square / Fisher exact has been performed to asses the significance of association between age, gender, co morbid conditions , previous HD access, procedure under gone & out comes.

Age >50 yrs is positively associated with failures [73.9% vs 26.1% for <50 yrs],with p =0.247. [but not statistically significant]

Male patients had more failures 52.2% compared to 47.8% in females .But the patency rate was more in males [69.2%] compared to females [30.8%]. P=0.179 [but statistically not significant.]

Diabetic patients had more failures [91.3%] compared to hypertensive patients [73.9%] .{p=0.464 for DM ,p=0.334 for hypertensive}, but statistically not significant.

Presence of an IJV line had maximum number of failure of fistula[91.3%] which is statistically significant value [p=0.001]

Patients who underwent Radio cephalic fistula had more failures [86.9%] compared to Brachio cephalic [13.0%] which was statistically significant [p=0.003].

Statistical Methods: Descriptive statistical analysis has been carried out in the present study. Results on continuous measurements are presented on Mean ± SD (Min-Max) and results on categorical measurements are presented in Number (%). Significance is assessed at 5 % level of significance. Student t test (two tailed, independent) has been used to find the significance of study parameters on continuous scale between two groups Inter group analysis) on metric parameters, . Chi-square/ Fisher Exact test has been used to find the significance of study parameters on categorical scale between two or more groups. Pearson correlation between flow rate and diameter of vein and artery is computed

Standard deviation: $SD = \sqrt{\frac{\sum (x - \bar{x})^2}{n-1}}$

1: Fisher Exact test

Let there exist two such variables X and Y, with m and n observed states, respectively. Now form an $m \times n$ matrix in which the entries a_{ij} represent the number of observations in which $x = i$ and $y = j$. Calculate the row and column sums R_i and C_j, respectively, and the total sum

$$N = \sum_i R_i = \sum_j C_j$$

of the matrix. Then calculate the conditional probability of getting the actual matrix given the particular row and column sums, given by

$$P_{\text{cutoff}} = \frac{(R_1!\, R_2! \cdots R_m!)\,(C_1!\, C_2! \cdots C_n!)}{N!\, \prod_{i,j} a_{ij}!},$$

which is a multivariate generalization of the hypergeometric probability function.

2.Chi-Square Test

$\chi^2 = \frac{\sum (Oi - Ei)^2}{Ei}$, Where Oi is Observed frequency and Ei is Expected frequency

3. Student t test (Two tailed, independent)

$$t = \frac{(\bar{x}_1 - \bar{x}_2) - (\mu_1 - \mu_2)}{\sqrt{s^2 (1/n1 + 1/n2)}}$$

Where $s^2 = \frac{(n1-1)\sum_{i=1}^{n1}(x1 - \bar{x}1)^2 + (n2-1)\sum_{i-1}^{n2}(x2 - \bar{x}2)^2}{n1 + n2 - 2}$

4. t-test of a correlation coefficient

Objective: To investigate whether the difference between the sample correlation co-efficient and zero is statistically significant.

Limitations: It is assumed that the x & y values originates from a bivariate normal distribution and that relationship is linear. To test an assumed value of population co-efficient other than zero, refer to the Z-test for a correlation co-efficient.

$$r = \frac{\sum (x - \bar{x})(y - \bar{y})}{\sqrt{\sum (x - x)^2 \sum (y - y)^2}}$$

$t = \frac{r\sqrt{(n-2)}}{\sqrt{(1-r^2)}}$ is calculated and follows student t distribution with n-2 degrees of freedom.

5.Classification of Correlation Co-efficient (r)

Up to 0.1	Trivial Correlation
0.1-0.3	Small Correlation
0.3-0.5	Moderate Correlation
0.5-0.7	Large Correlation
0.7-0.9	V.Large Correlation
0.9- 1.0	Nearly Perfect correlation
1	Perfect correlation

6.Significant figures

+ Suggestive significance (P value: $0.05<P<0.10$)

* Moderately significant (P value:$0.01<P \leq 0.05$)

** Strongly significant (P value : $P\leq0.01$)

Statistical software: The Statistical software namely SAS 9.2, SPSS 15.0, Stata 10.1, MedCalc 9.0.1 ,Systat 12.0 and R environment ver.2.11.1 were used for the analysis of the data and Microsoft word and Excel have been used to generate graphs, tables etc**.**

References:

1. Bernard Rosner (2000), Fundamentals of Biostatistics, 5^{th} Edition, Duxbury, page 80-240
2. M. Venkataswamy Reddy (2002), Statistics for Mental Health Care Research, NIMHANS publication, INDIA, page 108-144
3. Sunder Rao P S S , Richard J : An Introduction to Biostatistics, A manual for students in health sciences , New Delhi: Prentice hall of India. 86-160
4. John Eng (2003), Sample size estimation: How many Individuals Should be Studied? . Radiology 227: 309-313

Acknowledgement:
Dr.K.P.Suresh, Scientist (Biostatistics), National Institute of Animal Nutrition & Physiology, Bangalore-560030.

for reviewing the research methodology and statistical results of the study

Please contact for correction/modifications if any

Contact:
sureshkp97@gmail.com
9481251968/9341321900/9341364359/9663590140

DISCUSSION

Discussion

The data with current study was compared with Robbin et al & Allon et al.
The average age incidence with current study was 53.04yrs, 54 yrs in Robbin et al but 72% of patients in Allon et al were of 65 years of age.
The male population in current study was compared to Robbin et al [64% vs 39%], but the female population was comparable [35.80% vs 30%].
The female population was 46% in Allon et al.
The incidence of Diabetes was more in present study [85.10% vs 61%] compared to Robbin et al.
The incidence of Hypertension was 85.10% in current study ,b ut not mentioned in comparative studies.
The incidence of previous access procedure was 65.7% & 75 patients had previous access.
Maximum number patients underwent Radiocephalic fistula 62.7% vs 48% compared to Allon et al.
The duration of the current study was 24 months& it was 17 & 23 months respectively in Allon & Robbin et al.
The mean venous diameter for patency in current study was 4.34 +/- 0.94, vs 4.9+/- 20 in Robbin et al.
The mean venous diameter for failure in current study was 2.93 +/- 0.38 at first month & was 3.20 +/- 0.84 at third month. It was 3.4+/- 20 in Robbin et al.
The increase in size of the vein was 3.5 mm or more at 63% at 1 month & 84.6 % at 3 month in current study & it was 4mm or more at 54% at 2month,59% at 3months,56% at 4 months in Robbin et al .
The mean flow rates for patency was 464ml/min in current study & 780ml/min in Robbin et al.
The mean flow rates for failures in current study was 253.5ml/min & it was 418ml/min in Robbin et al.
The functional patency in current study was 62.90% vs 54% compared to Allon et al.
Early failure was comparable with Silva et al at 8.10% vs 8.30%.
There was no mention of immediate or primary failure by Robbin or Allon et al,which was 25.80% & 3.20% respectively.
The complication rate was 11.30% in current study but there were no complications in Silva et al.

Conclusion

Conclusion

This study shows that the preoperative vessel mapping provides useful information regarding the choice of AVF Vascular mapping leads to increased creation and use of native AVFs.

After VA creation, DU is most commonly used to deal with cannulation difficulties, but is useful as first diagnostic tool in other commonly encountered VA problems such as dysmaturation, arm swelling and hand ischemia.

Pre-existing arterial disease can be assessed by ultrasound assessment that is particularly important for the radial artery.

Clinical assessment may be inconclusive in a considerable proportion of patients, for instance when veins are not apparent in the obese.

Preoperative duplex resulted in an increase in the number of AVF & also improvement in adequacy of forearm AVF.

It can improve the results of HD access procedures by selecting the most valuable veins.

Preoperative duplex reduces the incidence of negative exploration.

Identifying AVF with potential problems early means that further intervention or surgery can be planned earlier, which will have a positive impact on patients.

Post op duplex may be useful in triaging the subsequent treatment of the immature fistula to the appropriate surgical or interventional service.

Moreover ,salvage procedure to correct the remediable anatomical problems can substantially increase the proportion of fistulas for dialysis.

Access surveillance duplex scanning at 4 & 12 weeks postoperatively is viable & has a high sensitivity & specificity for final outcome of fistula.

Serial surveillance of asymptomatic arteriovenous hemodialysis access for the detection & treatment of stenosis may reduce the risk of thrombosis & prolong access survival more than usual clinical monitoring.

Pre-operative ultrasound assessment predicts AVF patency and maturation for dialysis.

Venous diameter is an important criterion in the preoperative mapping sonogram.

Preoperative arterial diameter is important in predicting the success rate of forearm fistulas

Fistulas using radial arteries with diameters of less than 1.5 mm were less likely to be usable for dialysis compared with those using larger-caliber arteries.

AVFs, as compared with arteriovenous grafts, are the preferred hemodialysis vascular access because they have greater longevity and less frequent infections

A substantial proportion (28%–53%) of AVFs never mature adequately to be usable for dialysis

Accordingly, the time spent waiting for the AVF to mature can be substantial. Patients typically spend this time undergoing dialysis three times a week by means of a catheter.

If the AVF never matures, this is time wasted. In addition, there is increased risk of catheter infection with the attendant morbidity and cost . Thus, the ability to predict whether an AVF is going to mature eventually is important. Early recognition that the fistula is unlikely to mature can lead to fistula evaluation and possible revision or placement of a new vascular access

An adequate fistula diameter is important, as a 15-gauge hemodialysis needle is placed into the vein by means of palpation and visual inspection. Our initial hypothesis based on clinical experience was that a minimum venous size of 0.4 cm is needed for easy cannulation.

The draining vein needs to be of a certain size not only for ease in needle placement but also for carrying adequate blood flow. The optimal criterion for minimum venous diameter is a trade-off between sensitivity and specificity. It is important to correctly identify fistulas that are likely to mature, as well as those that will not. The overall accuracy of this criterion is optimal (72%–74%) when the minimum venous diameter cutoff is 0.3–0.4 cm.

The ability to maintain adequate blood flow during hemodialysis is another crucial determining factor in AVF maturity. In the United States, hemodialysis is typically performed at a dialysis blood flow rate of 350–450 mL/min, for 3.5–4 hours three times per week. A fistula blood flow rate less than 350 mL/min cannot sustain the desired dialysis blood flow rate and therefore results in inadequate dialysis. Blood flow rate has been measured to be at least 350–500 mL/min in normally functioning AVFs

The blood flow rate through the fistula must exceed the minimum acceptable dialysis blood flow rate of 350 mL/min by at least 100 mL/min to ensure successful use of the fistula for dialysis, or the vein could collapse during hemodialysis.

Factors such as venous diameter and depth from the skin also determine whether a fistula is successful. For this reason, not every fistula that meets the blood flow criteria is usable for dialysis.

A potential problem with a single measurement of fistula diameter and blood flow rate is that both the diameter and the flow may increase with time. Thus, more than one measurement may be needed to accurately predict maturation potential.