Results

The study comprised 80 patients with chronic renal failure, there were 50 males (62.5%) and 30 female patients (37.5%). Twenty-three males were non-diabetics and 27 patients were diabetic; while 17 female patients were non-diabetic and 13 females were diabetics, (Table 5). There were a non-significant (X^2=0.177, p>0.05) difference between the gender distribution between diabetic and non-diabetic patients, (Fig. 22).

Table (5): Patients distribution among both studied groups according to gender

	Non-diabetic Patients	Diabetic Patients	Total
Males	23 (28.8%)	27 (33.7%)	50 (62.5%)
Females	17 (21.2%)	13 (16.3%)	30 (37.5%)
Total	40 (50%)	40 (50%)	80 (100%)

The mean age of patients enrolled in the study was 57±12.4; range: 26-79 years; the mean age of non-diabetic patients was 57.3±13.1; 29-77 years while that of diabetic patients 56.7±11.9; range: 26-79 years. There was a non-significant (p>0.05) decrease of age of diabetic patients compared to that of non-diabetic, (Fig. 23).

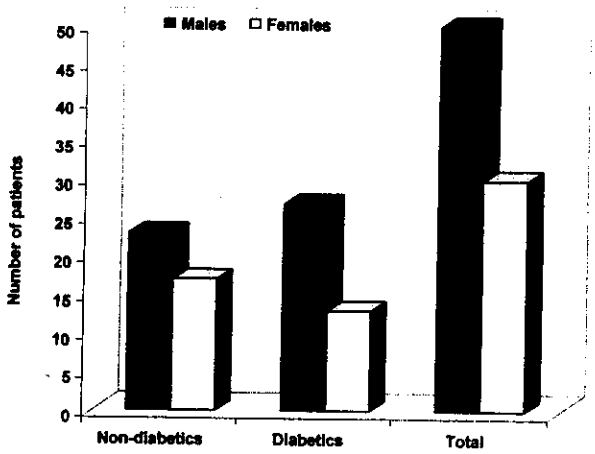


Fig (22) Patients distribution among both groups according to patients' gender

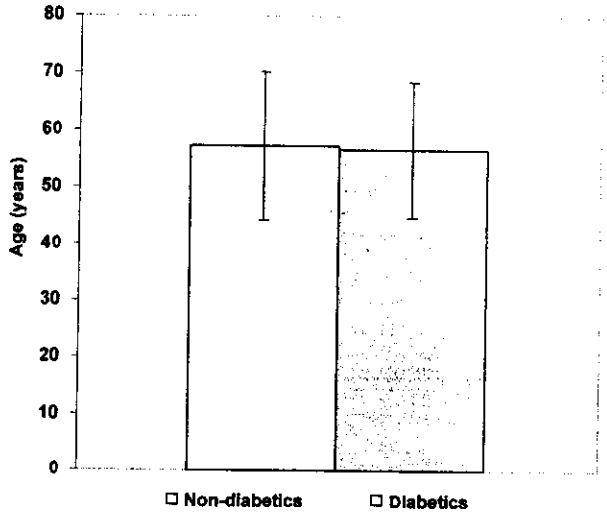


Fig (23) Mean age of studied patients in both groups

Patients distribution among age strata showed non-significant (X^2=0.162, p>0.05) difference between diabetic and non-diabetic groups; despite the finding that non-diabetic patients were non-significantly older than diabetic patients, (Table 6, Fig. 24).

Table (6): Patients' distribution among age strata between both studied groups

	Non-diabetic Patients		Diabetic Patients		Total	
	Number (%)	Mean±SD	Number (%)	Mean±SD	Number (%)	Mean±SD
26-35	3 (3.75%)	31±2	2 (2.5%)	30.5±6.4	5 (6.25%)	30.8±3.5
>35-45	5 (6.25%)	40.6±4	4 (5%)	39.5±1.3	9 (11.3%)	40.1±3
>45-55	10 (12.5%)	52±2.7	9 (11.3%)	48.8±2.3	19 (23.8%)	50.2±2.7
>55-65	9 (11.3%)	61.6±2.3	17 (21.2%)	60.9±2.5	26 (32.4%)	60.8±2.5
>65-75	11 (13.7%)	69.9±3	7 (8.75%)	70.7±2.3	18 (22.5%)	69.9±2.9
>75	2 (2.5%)	76.5±0.7	1 (1.25%)	79	3 (3.75%)	77.3±1.5
Total	40 (50%)	57.3±13.1	40 (50%)	56.7±11.9	80 (100%)	57±12.4

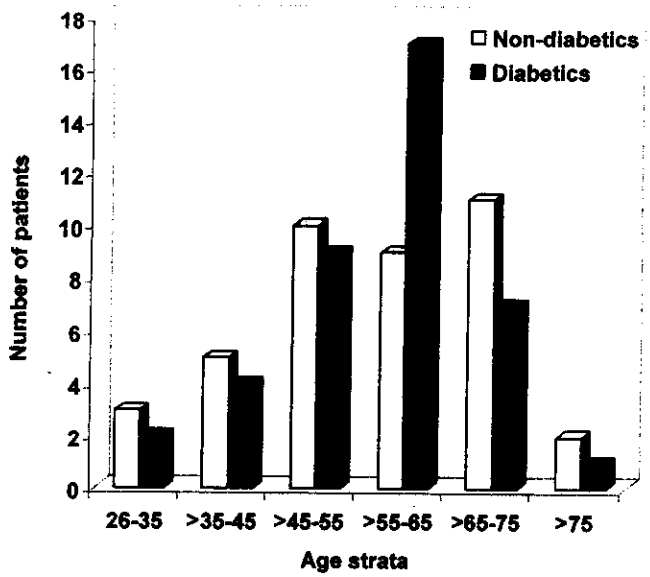


Fig (24)Patients' distribution among age strata between both studied groups

The underlying etiology of ESRD in diabetic group was diabetic nephropathy in 30 patients and hypertension in 4 patients, primary glomerular disease in 2 patients, and with miscellaneous etiologies in 4 patients. On the other hand, in non-diabetic patients, hypertension was determined in 13 patients, primary glomerular disease in 8 patients, obstructive uropathy in 3 patients and familial disease and pregnancy-related uropathy each in one patient and 14 patients had miscellaneous etiologies, (Table 7, Fig. 25).

Table (7): Patients' distribution according to etiology of ESRD between both studied groups

	Non-diabetic Patients	Diabetic Patients	Total
	Number (%)	Number (%)	Number (%)
Diabetes mellitus	0	30 (37.5%)	30 (37.5%)
Hypertension	13 (16.25%)	4 (5%)	17 (21.25%)
Primary glomerular disease	8 (10%)	2 (2.5%)	10 (12.5%)
Obstructive uropathy	3 (3.75%)	0	3 (3.75%)
Heredo-familial disease	1 (1.25%)	0	1 (1.25%)
Pregnancy related	1 (1.25%)	0	1 (1.25%)
Miscellaneous & Unknown	14 (17.5%)	4 (5%)	18 (18.5%)
Total	40 (50%)	40 (50%)	80 (100%)

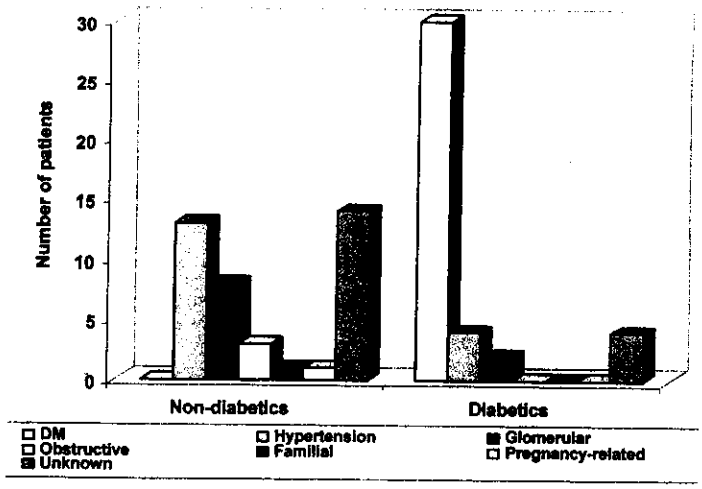


Fig (25)Patients' distribution among studied groups according to etiology of ESRD

The ESRD is not a mono-morbid disease; 33 patients had coronary artery disease; 18 in diabetic and 15 in non-diabetic group, peripheral vascular disease was found in 19 patients; 12 diabetic and 7 non-diabetics, retinopathy was detected in 31 patients; 25 diabetics and 6 non-diabetics, previous stroke was reported in one diabetic and 2 non-diabetic patients, while one diabetic patient had above knee amputation. Obesity was reported in 18 patients; 13 diabetics and 5 non-diabetics and 34 patients were smokers; 19 non-diabetics and 15 diabetics, (Table 8, Fig. 26).

Table (8): Patients' distribution according to co-morbid diseases in patients of both studied groups

	Non-diabetic Patients	Diabetic Patients	Total
	Number (%)	Number (%)	Number (%)
Coronary artery disease	15 (18.75%)	18 (22.5%)	33 (41.25%)
Peripheral vascular diseases	7 (8.75%)	12 (15%)	19 (23.75%)
Retinopathy	6 (7.5%)	25 (31.25%)	31 (38.75%)
Stroke	2 (2.5%)	1 (1.25%)	3 (3.75%)
Amputation	0	1 (1.25%)	1 (1.25%)
Obesity	5 (6.25%)	13 (16.25%)	18 (22.5%)
Smoking	19 (23.75%)	15 (18.75%)	34 (42.5%)

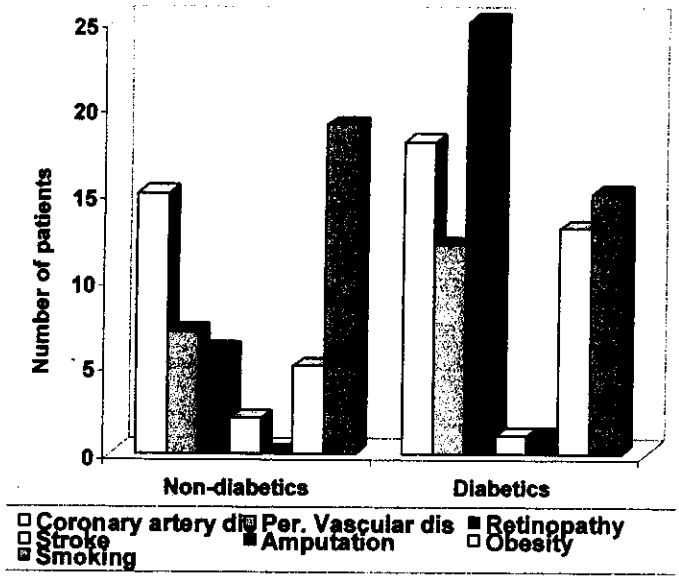


Fig (26) Patients' distributionamong studied groups according to comorbid

Laboratory Investigations

A) Diagnostic laboratory findings

- Serum urea was 242.3±12.7; range: 195-256 mg/dl in diabetic patients and was 237±16; range: 200-256 mg/dl in non-diabetic patients. There was a non-significant difference (Z=1.819, p>0.05) in estimated serum urea in both groups, (Table 9, Fig. 27).
- Serum creatinine was 7.2±1.1; range: 5.7-9.2 mg/dl in diabetic patients and was 7.3±1; range: 5.5-9.2 mg/dl in non-diabetic patients. There was a non-significant difference (Z=0.672, p>0.05) in estimated serum creatinine level in both groups, (Table 9, Fig. 28).
- Creatinine clearance rate was 11.7±2.6; range: 7-15.4 ml/min in diabetic patients and was 10.8±2.4; range: 7-15 ml/min in non-diabetic patients. There was a non-significant difference (Z=1.595, p>0.05) in estimated creatinine clearance levels in both groups, (Table 9, Fig. 29).

Table (9): Estimated serum levels of urea, creatinine and creatinine clearance rate in both studied groups

	Non-diabetic Patients		Diabetic Patients	
	Mean±SD	Range	Mean±SD	Range
Serum urea (mg/dl)	237±16	200-256	242.3±12.7	195-256
Serum creatinine (mg/dl)	7.3±1	5.5-9.2	7.2±1.1	5.7-9.2
Creatinine clearance rate (ml/min)	10.8±2.4	7-15	11.7±2.6	7-15.4

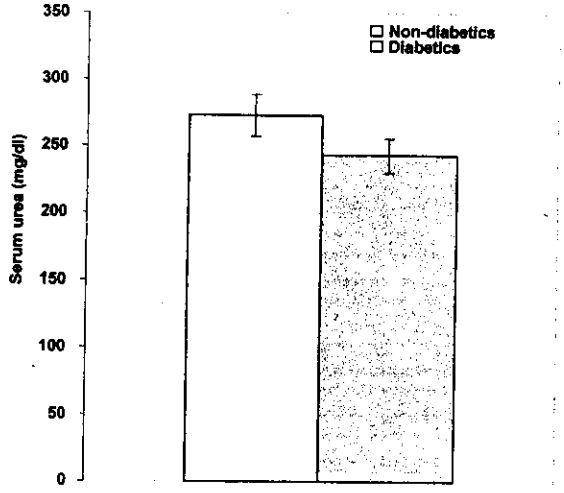


Fig (27) Mean SD +of serum urea estimated in studied patients of both groups

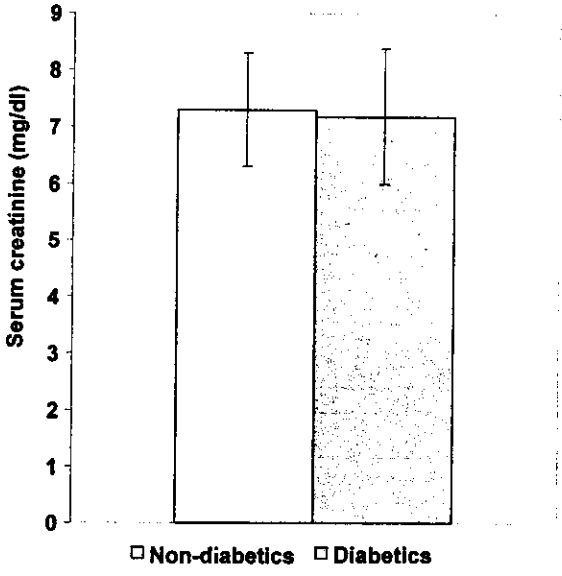
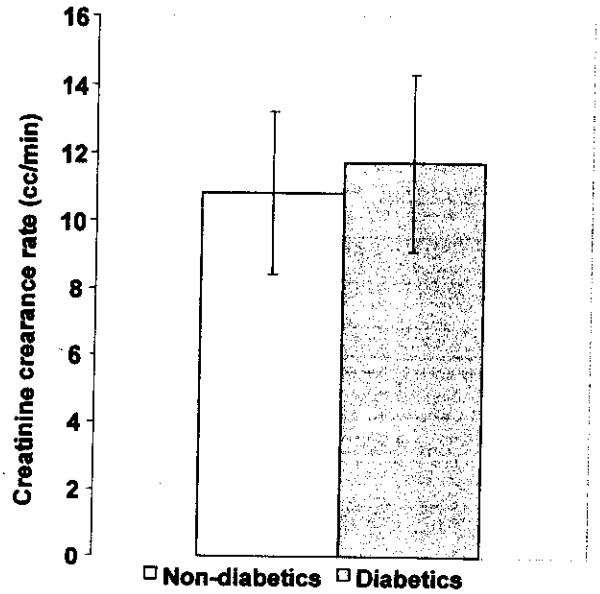


Fig (28) Mean ± SDof serum creatinine estimated in studied patients of both groups



Fig(29) Mean ± SD of creatinine clearance rate estimated in studied patients of both groups

B) Estimation of blood glucose levels

- Fasting blood glucose level was 325.6±72.2; range: 215-469 mg/dl in diabetic patients and was 99.7±14.8; range: 70-135 mg/dl in non-diabetic patients. There was a significant increase ($Z=1.819$, $p>0.05$) in estimated fasting blood glucose level in diabetic group compared to non-diabetic group, (Table 10 Fig. 30).
- Two-hour postprandial blood glucose level was 358±79; range: 235-515 mg/dl in diabetic patients and was 105±15; range: 74-140 mg/dl in non-diabetic patients. There was a significant increase ($Z=0.672$, $p>0.05$) in estimated 2-hr postprandial blood glucose level in comparison to fasting blood glucose level in diabetic group and in comparison to postprandial blood glucose level in control group, (Table 10, Fig. 31).

Table (10): Estimated serum levels of urea, creatinine and creatinine clearance rate in both studied groups

	Non-diabetic Patients		Diabetic Patients	
	Mean±SD	Range	Mean±SD	Range
Fasting blood glucose (mg/dl)	99.7±14.8	70-135	325.6±72.2	215-469
Postprandial blood glucose (mg/dl)	105±15	74-140	358±79	235-515

C) Estimation of homocysteine and anticardiolipin antibodies:

The mean serum homocysteine level was 4.8±1.5umol/l in diabetic group and 4.6±1.8umol/l in non diabetic group. Statistically, the difference between the two groups was insignificant, P>0.5.

The anticardiolipin antibodies were not detected in both groups of patients.

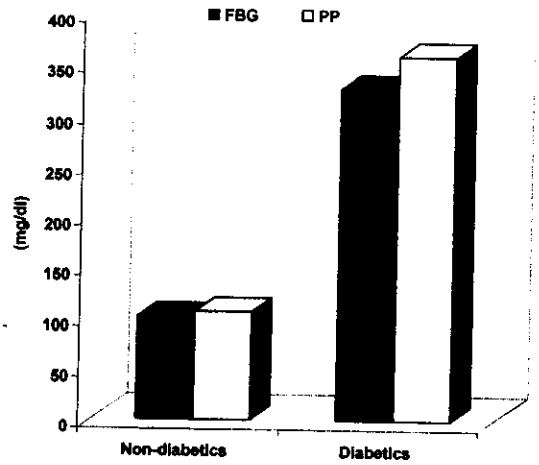


Fig (30) Mean preoperative blood glucose level fasting & postprandial estimated in patients of both groups

Radiologic Investigations

A) Plain X-ray studies

- Plain X-ray studied demonstrated excessive arterial calcification of the peripheral radial artery in 2 diabetic patients, (Fig. 10).

Fig.(31): Plain X-ray demonstrating excessive arterial calcification of the peripheral radial artery.

B) Preoperative Doppler assessment of venous diameter:

- The mean vein diameter was 4.08±0.98; range 2-5 mm. In diabetic patients the mean diameter was 5.1±1.7 while, it was 4.1±1 mm in non-diabetics, with a non-significant difference ($p>0.05$) between the venous diameters of used veins in both groups, (Fig. 32).
- Seven patients (8.75%) had venous diameter of 2 mm, 14 patients (17.5%) had venous diameter of 3 mm, 25 patients (31.25%) had venous diameter of 4 mm and 34 patients (42.5%) had venous diameter of 5 mm. There was a non-significant difference between both groups as regards the distribution of patients according to the diameter of the used vein, ($X^2=0.612$, $p>0.05$), (Table 11, Fig. 33).

Table (11): Preoperative Doppler venous diameter data

		Non-diabetics	Diabetics	Total
Mean±SD (mm)		4.1±1	4.05±0.98	4.08±0.98
Venous diameter	**2 mm**	3 (3.75%)	4 (5%)	7 (8.75%)
	3 mm	8 (10%)	6 (7.5%)	14 (17.5%)
	4 mm	11 (13.75%)	14 (17.5%)	25 (31.25%)
	5 mm	18 (22.5%)	16 (20%)	34 (42.5%)
	Total	40 (50%)	40 (50%)	80 (100%)

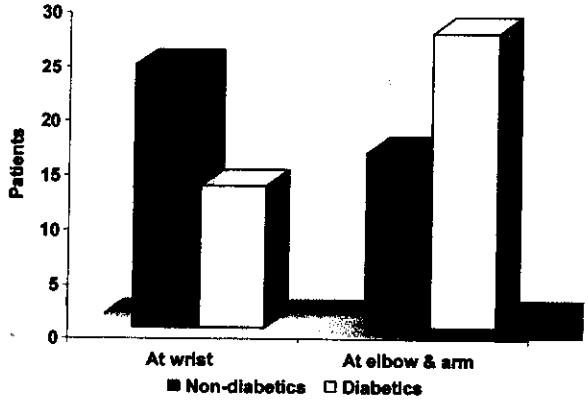


Fig (34) Patients' distribution according to the site of the created AVF

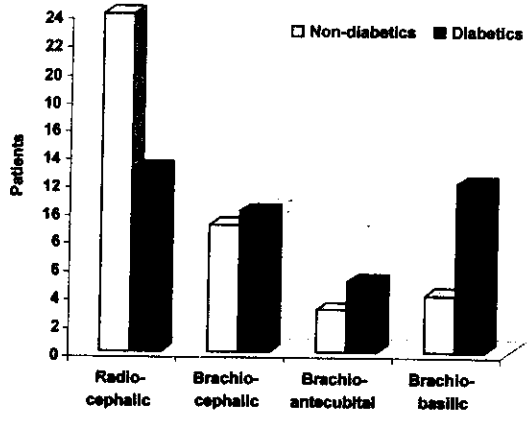


Fig (35) Patients' distribution according to the site of AVF created in both groups

B) AVF Maturation Time

- At 1-month PO, 27 AVF (33.8%); 15 in non-diabetics and 12 in diabetics were mature.
- At 2-month PO, 53 AVF (66.3%); 28 in non-diabetics and 25 in diabetics were mature.
- At 3-months PO, 70 AVF (87.5%); 37 in non-diabetics and 33 in diabetics were mature; while the other 10 AVF were non-mature, non-functioning and required revision with a success rate of primary AVF creation is 87.5%, (Table 13, Fig. 36).
- Maturation of created AVF was non-significantly earlier in non-diabetics compared to diabetic patients, (X^2=0.45, p>0.05).
- Moreover, the success rate of primary fistula creation was non-significantly higher in non-diabetics compared to diabetic patients, (X^2=1.96, p>0.05).

Table (13): Patients distribution according to time of AVF maturation

		Non-diabetics	Diabetics	Total
1-month		15 (21.4%)	12 (30%)	27 (33.8%)
2-months		28 (70%)	25 (62.5%)	53 (66.3%)
3-months		37 (92.5%)	33 (82.5%)	70 (87.5%)
Total	Success	37 (92.5%)	33 (82.5%)	70 (87.5%)
	Failure	3 (7.5%)	7 (17.5%)	10 (12.5%)

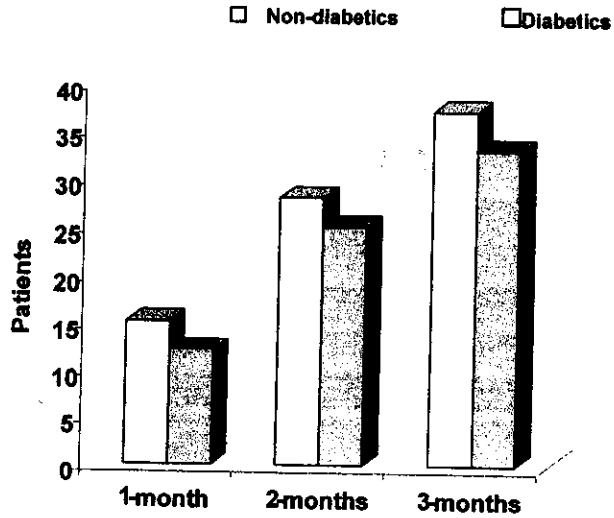


Fig (36) Patients' distribution according to the time of AVF maturation in both groups

C) Doppler flow-rate in Created Fistulae

❖ Color Doppler study showed the perivascular, mosaic color assignment due to tissue vibration visible immediately deep to the nidus (arrow, 37a) at a low color Doppler velocity scale setting. At a higher velocity scale (37b) the feeding artery (a) and vein (v) can be distinguished. Pulsed Doppler demonstrates high velocity, low resistance arterial (37c) and pulsatile venous flow (37d), characteristic of AV shunting.

Fig. (37a): Mosaic color assignment (arrow) due to AVF.

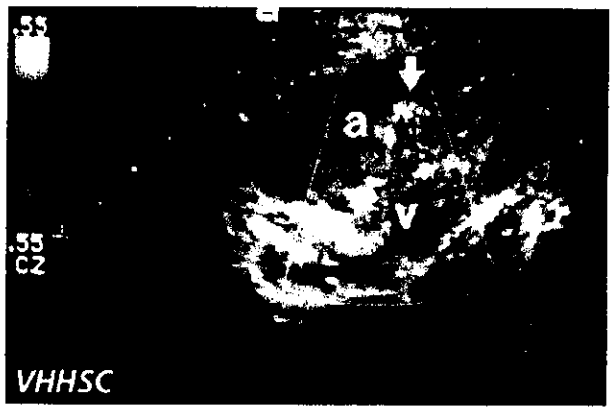


Fig. (37b): Feeding artery (a) and vein (v) seen entering/ leaving the nidus of an AVF.

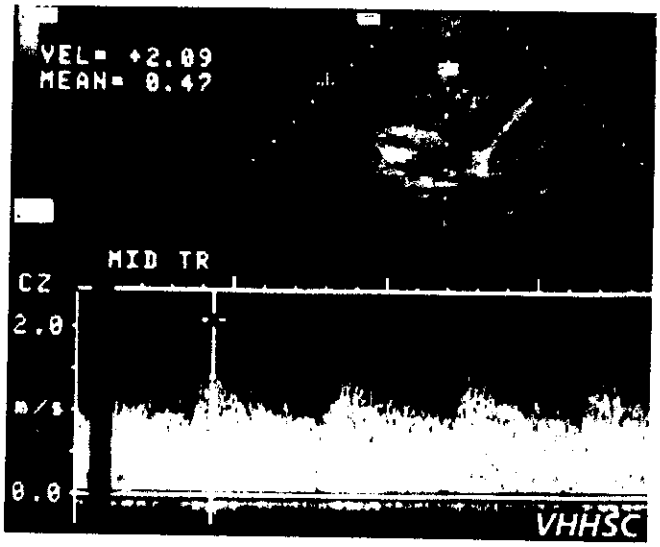


Fig. (37c): High velocity, low resistance flow due to AVF.

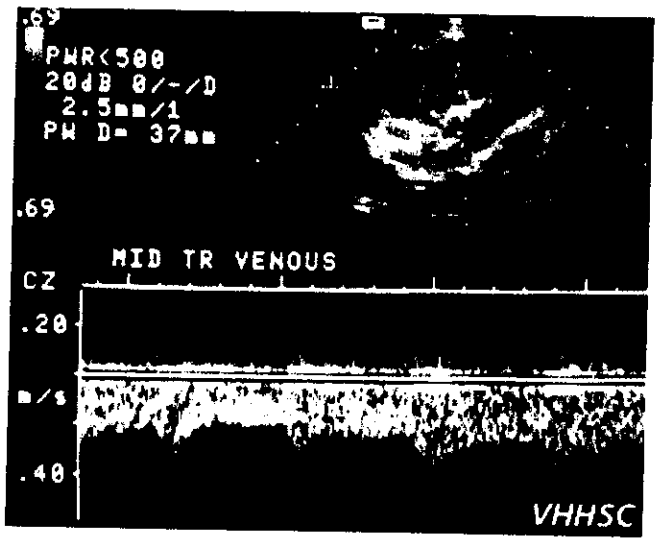


Fig. (37d): Pulsatile venous flow due to AVF.

- ❖ The mean flow-rate showed significant ($p<0.01$) progressive increase with time of maturation in both groups irrespective of the site of the fistula, (Fig.38).
- ❖ Moreover, the mean flow-rate was non-significantly higher in non-diabetics compared to diabetic group, (Table 14, Fig. 39).

Table (14): Mean (SD) of blood flow rate in created fistulae detected by Doppler study in both groups

	Non-diabetic		Diabetic	
	Radial fistula	Brachial fistulae	Radial fistula	Brachial fistulae
1-month	445±71.7	638±70	397.5±77	553±94
2-months	556±90	717±80	547±107	649±110
3-months	690±113	797±88	636±152	748±126

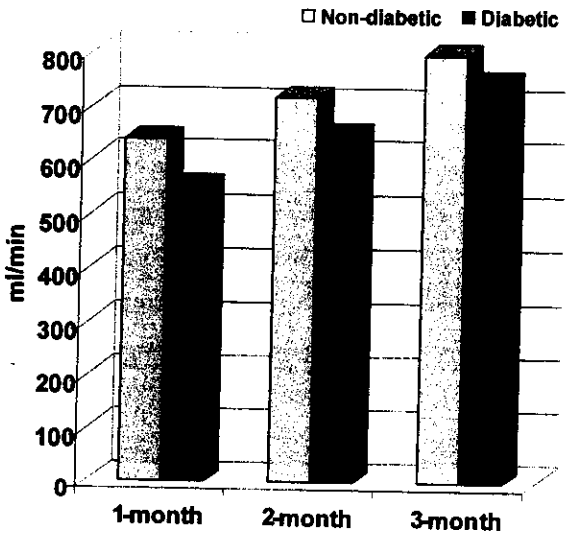


Fig (38) Flow- rate detected at brachial AVF in both groups till 3 months after surgery

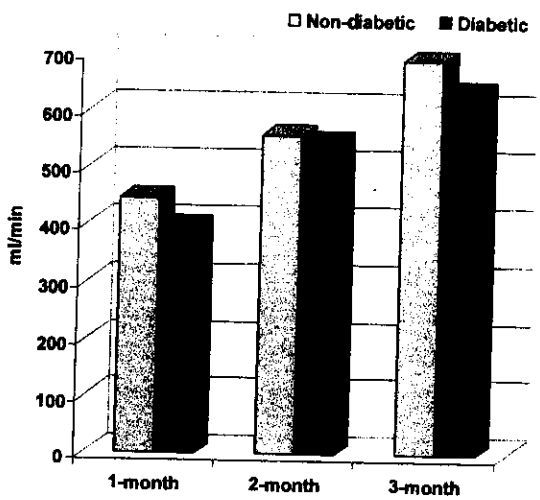


Fig (39) Flow rate detected at radial AVF in both groups till ٣months after surgery

D) AVF Patency Rate

- At 1-month PO, all created AVF; 37 radial and 43 brachial fistulae were patent.
- At 3-months PO, 70 AVF (87.5%); 30 radial and 40 brachial in 35 non-diabetic and 35 diabetics patients were patent.
- At 6-months PO, 65 AVF (81.25%); 27 radial and 38 brachial in 34 non-diabetic and 31 diabetics patients were patent.
- At 9-months PO, 63 AVF (78.75%); 25 radial and 38 brachial in 33 non-diabetic and 30 diabetics patients were patent.
- At 12-months PO, 61 AVF (76.25%); 24 radial and 37 brachial in 32 non-diabetic and 29 diabetics patients were patent.
- At 15-months PO, 59 AVF (73.75%); 23 radial and 36 brachial in 31 non-diabetic and 28 diabetics patients were patent.
- At 18-months PO, 58 AVF (72.5%); 22 radial and 36 brachial in 30 non-diabetic and 28 diabetics patients were patent, (Table 15).

Table (15): Patients' distribution according to the patency rate of created AVF throughout the follow-up period

	Non-diabetic		Diabetic		Total	
	Radial fistula	Brachial fistula	Radial fistula	Brachial fistulae	Radial fistula	Brachial fistulae
1-month	24	16	13	27	37	43
3-months	20	15	10	25	30	40
6-months	19	15	8	23	27	38
9-months	18	15	7	23	25	38
12-months	17	15	7	22	24	37
15-months	17	14	6	22	23	36
18-months	16	14	6	22	22	36

Analysis of the patency rates

- Total Outcome at end of follow-up
  - 58 AVF were still patent and working efficiently with a patency rate was 72.5% and 22 AVF required revision with a non-functioning rate of 27.5%.
  - 4 of revised AVF re-occluded; 3 in diabetic patients and one in non-diabetic patient and required revision for the second time. Two of these AVF were radial, one was brachio-antecubital and one was brachio-cephalo and all of the 4 patients had brachio-basilic AVF with superficialization, (Fig. 40)

- The patency rate according to site of primary fistula creation:
  - The total patency rate was 83.7% in brachial fistulae and 59.5% in radial fistulae, (Fig. 41). There was a significant (X^2=5.68, $p<0.01$) increase of patency rate on using the brachial artery compared to usage of radial artery as feeding vessel.
  - The patency rate of radial fistulae was 66.7% and 46.2% in non-diabetics and diabetics respectively, while the patency rate of brachial fistulae was 93.75% and 81.5% in non-diabetics and diabetic patients, respectively, (Fig. 42).

- The patency rate in non-diabetic patients was 75% and in diabetic patients was 70%. There was a significant (X^2=3.94, $p<0.05$) increase of patency rate in non-diabetics compared to diabetics and irrespective of the feeding artery. Moreover, there was a significant (X^2=6.115, $p<0.01$) increase of patency rate in favor of using brachial artery as feeding vessel in both groups of patients

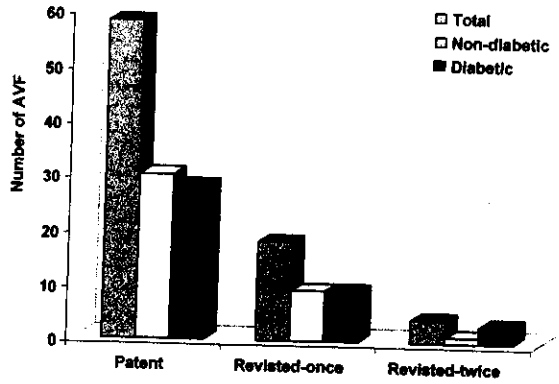


Fig (40) Final outcome at end of follow – up

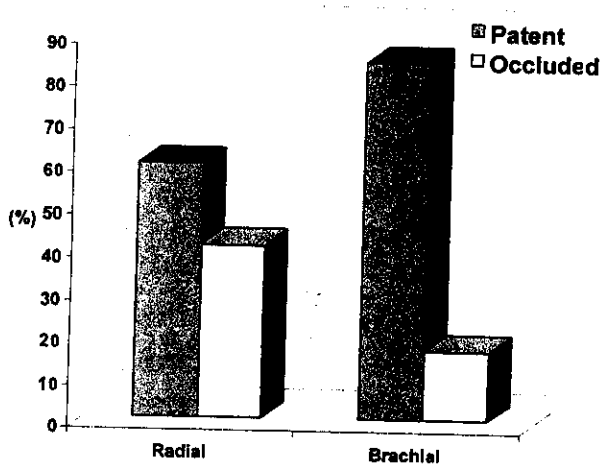


Fig (41) Patency rate according to the site of AVF creation named by the used artery

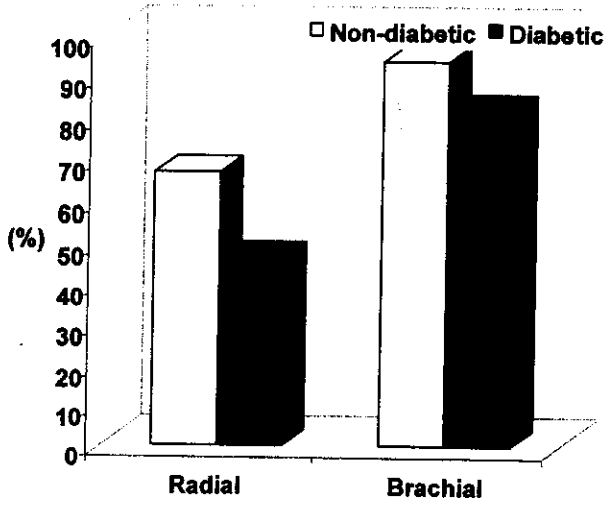


Fig (42) Patency rate according to the site of AVF creation named by the used studied groups artery among

- ❖ The patency rate according to flow-rate at 3-months after primary fistula creation:
  - The mean flow rate in the patent AVF (n=58) was 788.4±71.4 ml/min; while in the revisited fistulae was 547.6±73.7 ml/min. There was a significant ($p<0.001$) decrease of mean flow rate in the failing fistulae, (Fig. 43).
  - There was a positive significant correlation ($r=0.834$, $p<0.001$) between the flow-rate at 3-months and the patency of the AVF, (Fig.43).

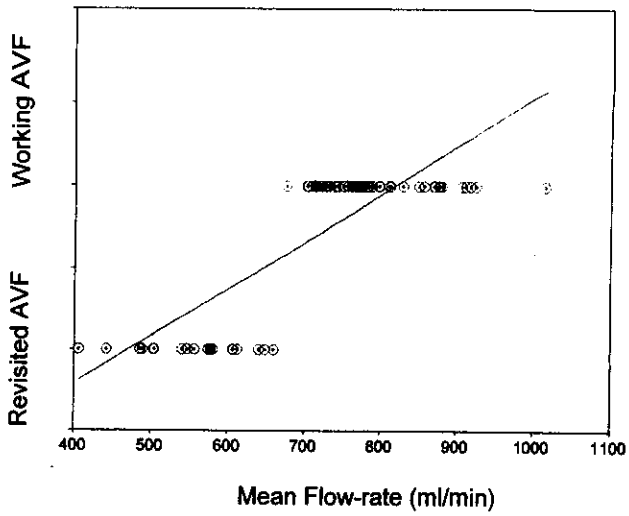


Fig. (43): Correlation between mean blood flow rate and outcome of AVF creation

Postoperative Complications

- ❖ Early PO Complications
  - Four patients; 2 in each group had operative site hematoma
  - Seven patients (8.8%); 3 non-diabetics and 4 diabetics had limb swelling.
  - Ten patients (12.5%); 3 non-diabetics and 7 diabetics had superficial wound infection.
  - These complications responded to conservative treatment and did not affect the surgical outcome.
- ❖ Prior to fistula maturation (1-3 month PO)
  - Seven patients (8.8%); 3 non-diabetics and 4 diabetics had early thrombosis and fistula failure.
  - Three patients (7.5%); one non-diabetic and 2 diabetics had severe operative site infection not responding to conservative treatment and caused failure of the fistula.

❖ Throughout follow-up period

- Late thrombosis occurred in 10 patients (12.5%); 4 non-diabetics and 6 diabetics.
- Local aneurysmal dilatation occurred in 2 patients (2.5%); one in each group, (Fig. 45).
- Steel syndrome occurred in 3 patients; one non-diabetic and 2 diabetics.
- Venous hypertension was reported in one diabetic patient.

❖ There was non-significantly (X^2=0.653, p>0.05) increase of the frequency of postoperative complications in diabetics compared to non-diabetic patients, (Table 16, Fig. 46).

Table (16): Patients distribution according to frequency of postoperative complications

Complications		Non-diabetics	Diabetics	Total
Early PO	Operative site hematoma	2 (5%)	2 (5%)	4 (5%)
	Limb swelling	3 (7.5%)	4 (10%)	7 (8.8%)
	Superficial wound infection	3 (7.5%)	7 (17.5%)	10 (12.5%)
Prior to fistula maturation	Thrombosis	3 (7.5%)	4 (10%)	7 (17.5%)
	Operative site severe infection	1 (2.5%)	2 (5%)	3 (7.5%)
During follow-up	Late thrombosis	4(10%)	6 (15%)	10 (12.5%)
	Local aneurysm	1 (2.5%)	1 (2.5%)	2 (5%)
	Steel syndrome	1 (2.5%)	2 (5%)	3 (3.75%)
	Venous hypertension	0	1 (2.5%)	1 (1.25%)
Total		19 (47.5%)	27 (67.5%)	46 (57.5%)

Fig.(45a): A case of brachio-cephalic AVF: After healing and maturation of the AVF; the line points to the distended vein of well-functioning AVF.

Fig.(45b): A case of brachio- cephalic AVF: After healing and maturation of the AVF; the line points to the saccular venous dilatation and a non-functioning AVF.

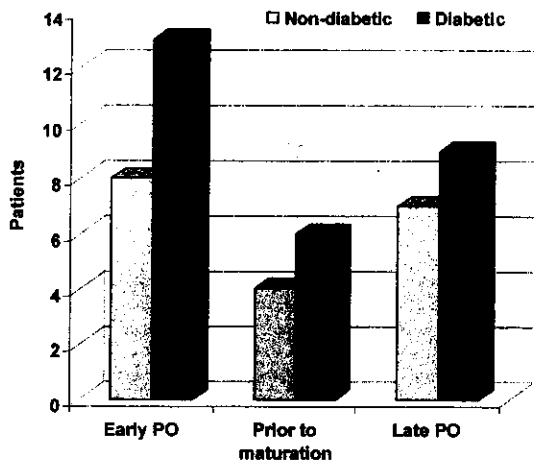


Fig (46): Patients' distribution according to the frequency of postoperative complications