Statistical analysis

The collected data was organized, tabulated and statistically analyzed using SPSS software statistical computer package version 12. For quantitative variables, the range, mean and standard deviation were calculated. The difference between two means was statistically analyzed using the students (t) test. Mann-Whitney test was performed to test difference of mean values of jet area as the variable was not found to follow the normal distribution. Pearson's correlation coefficient (r) was calculated to test the association between two variables. For categorical variables, the number and percent distribution was calculated. Monte Carlo test was used as a test of significance. Reliability of diagnostic test was calculated as sensitivity, specificity, positive and negative predictive values. Significance was adopted at $p<0.05$ for interpretation of results of tests of significance. ***(Petrie and Sabin 2005)***

The following equations were used:

$$\textbf{Mean} = \frac{\text{Sum total of all observations}}{\text{Number of observations}}$$

$$\textbf{Standard deviation (S.D.)} = \frac{\Sigma\ (\text{mean value} - \text{observations value})^2}{\text{Number of observations} - 1}$$

Where Σ = sum total

$$\textbf{Student t test} = \frac{\text{Mean}_1 - \text{Mean}_2}{\text{Pooled standard deviation}}$$

$$\textbf{Paired t test} = \frac{\text{Mean of the difference of observations before and after}}{\text{Standard error of the differences between observations}}$$

$$\textbf{Z} = \frac{[T_+ - 1/4\, n'(n'-1] - 1/2}{\sqrt{\{n'(n'+1)(2n'+1)/24}}$$

$$\textbf{Exact test} = \frac{(a+c)(b+d)(a+b)(c+d)}{a \times b \times c \times d \times n}$$

Where a, b, c, d = the observed value n= sample size

$$\textbf{Pearson's correlation coefficient (r)} = \frac{\Sigma xy - (\Sigma x \times \Sigma y)/n}{[\Sigma x^2 - (\Sigma x)^2/n]\ [\Sigma y^2 - (\Sigma y^2)/n]}$$

$$\textbf{Sensitivity} = \frac{\text{Diseased cases diagnosed by the test as positive}}{\text{All diseased}} \times 100$$

$$\textbf{Specificity} = \frac{\text{Non diseased cases diagnosed by the test as negative}}{\text{All non diseased}} \times 100$$

$$\textbf{Positive predictive value} = \frac{\text{Diseased cases diagnosed by the test as positive}}{\text{All tested as positive}} \times 100$$

$$\textbf{Negative predictive value} = \frac{\text{Non diseased cases diagnosed by the test as positive}}{\text{All tested as negative}} \times 100$$

The study was performed over 30 patients having variable degrees of mitral regurge. Divided by the etiology into two groups: Rheumatic and congenital.

Table (8) shows:-Clinical and Demographic Data of the rheumatic group.

Patients characters	No of patients
* Age - Range - Mean - SD	 6-16 years 11.42 3.17
* sex -male -female	 8 12
* Associated lesions - isolated MR - Double MR and MS - MR and Mild AR	 9 5 6
* Cardiomegally	7
* heart failure	3
* history of taking long acting penicillin	20
*Rheumatic heart disease	15
*Rheumatic arthritis	5

- The Rheumatic group was 20 patients, 10 of them having severe MR, 6 of them having moderate MR, 4 of them having mild MR (assessment done by pulsed Doppler).

- Their age was ranging from (6-16) years mean ± SD (11.42± 3.17) years

- 8 of them were males, 12 were females.

- 9 of them having isolated MR, 5 of them having double mitral lesion (MR associated with mitral stenosis), 6 of them associated with mild aortic regurge.

- Cardiomegally was found in 7 patients (with severe MR), 3 of them were in failure.

- All rheumatic patients had history of long acting penicillin intake and 15 of them were following up as rheumatic heart disease and other 5 had history of rheumatic arthritis.

Table (9) shows: - Clinical and demographic Data of the congenital group.

Patients characters	No of patients
*Age - Range - Mean - SD	**From 3 month to 4 years** 1.77 1.30
*sex - male - female	4 6
*Associated lesions - isolated MR - associated with other congenital anomalies	3 7
*Heart failure	1
*Cardio megally	zero
*Prenatal history - consanguinity - Drug intake - no +ve data	2 3 5

- The congenital group was 10 patients, 6 of them having moderate MR, 1 of them having severe MR, and 3 of them having mild MR.
- Their age was ranging from 3 months to 4 years, Mean ± SD (1.77 ± 1.3) year.
- 6 of them were females and 4 of them were males.
- 3 of them were isolated MR, 7 of them were associated with other congenital anomalies e.g. (cleft leaflet, ASD, TR).

- One patient of them was in failure, no cardiomegally detected in this group.
- In the congenital group history was taken from the mother (consanguinity , drug intake, x ray exposure)
- 2 of them were having +ve consanguinity, 3 of them was having history of drug intake and the rest 5 cases there was no positive prenatal history.

Table (10): Shows left ventricular end-systolic diameter (LVSD), Left ventricular end-diastolic diameters (LVDD) ejection fraction (EF), fractional shortening (FS) in the studied groups.

	Total	Mild MR	Moderate MR	Severe MR	P value
LVSD (mm)	3.6 ± 0.7	2.9 ± 0.6	3.4 ± 0.5	3.9 ± 0.9	0.072
LVDD(mm)	4.5 ± 0.6	4.1 ± 0.4	4.3 ± 0.4	4.7 ± 0.5	0.030
EF%	62 ± 4	67 ± 5	62 ± 3	64 ± 2	0.092
FS%	36 ± 7	34 ± 3	36 ± 3	31 ± 2	0.143

* P = 0.003 for mild to moderate and severe. P<0.001 for severe to mild and moderate

-left ventricular end-systolic diameter (LVSD), ejection fraction (EF), fractional shortening (FS); variables were not statistically different among MR groups. Left ventricular end-diastolic diameters (LVDD) were significantly increased in moderate-severe MR group than the mild MR group (P<0.05). And also left atrial ejection fraction was decreased in severe and moderate groups as compared to mild group (P<0.05)

Table (11) shows: - assessment of the severity of MR. Between the two groups of the study by measuring jet area.

Jet area /LA%	Congenital group	Rheumatic group
Mild	5 (50%)	4 (20%)
Moderate	4 (40%)	6 (30%)
Severe	1 (10%)	10 (50%)
Range	16-41	9-69
Mean	26.30	38.50
SD	10.18	19.04

Z = 1.584, p = 0.113 (Not significant)

- MR in the 2 groups of patients was assessed by pulsed Doppler and was graded into "mild – moderate – severe" and then confirmed by color Doppler assessment of jet area in correlation of left atrium area.
- In the rheumatic group the assessment of mitral regurge. By pulsed Doppler shows that (10 patients having severe MR, 6 patients having moderate MR, 4 patients having mild MR).
- By color Doppler in the same group the assessment of jet area in correlation of left atrium area was ranging from (9 – 69 %), their mean value was (38.5±19.04%).

- In the congenital group the assessment of mitral regurge. By pulsed Doppler shows that (1 patient having severe MR, 6 patients having moderate MR, 3 patients having mild MR).

- By color Doppler in the same group the assessment of jet area in correlation of left atrium area was ranging from (16-41%), their mean value was (26.3± 10.18%).

- The cut points for jet area / LA area were ≤ 20% in mild MR and ≥ 40% in severe MR and in between (20% - 40%) consider moderate***(Hall ,et al 1997***)

Table (12) shows: - Sensitivity, specificity +ve protective value, -ve predictive value of colored Doppler in comparison of pulsed Doppler.

Sensitivity	88.3%
specificity	56%
+ve protective value	84.5%
-ve predictive value	75%

- Sensitivity, specificity, positive predictive value, negative predictive value was calculated by comparison with quantitative pulsed Doppler assessment.

- Sensitivity was 88.3%, specificity 56% + ve predicative value was 84.5% - ve predictive value was 75%.

Figure "10"

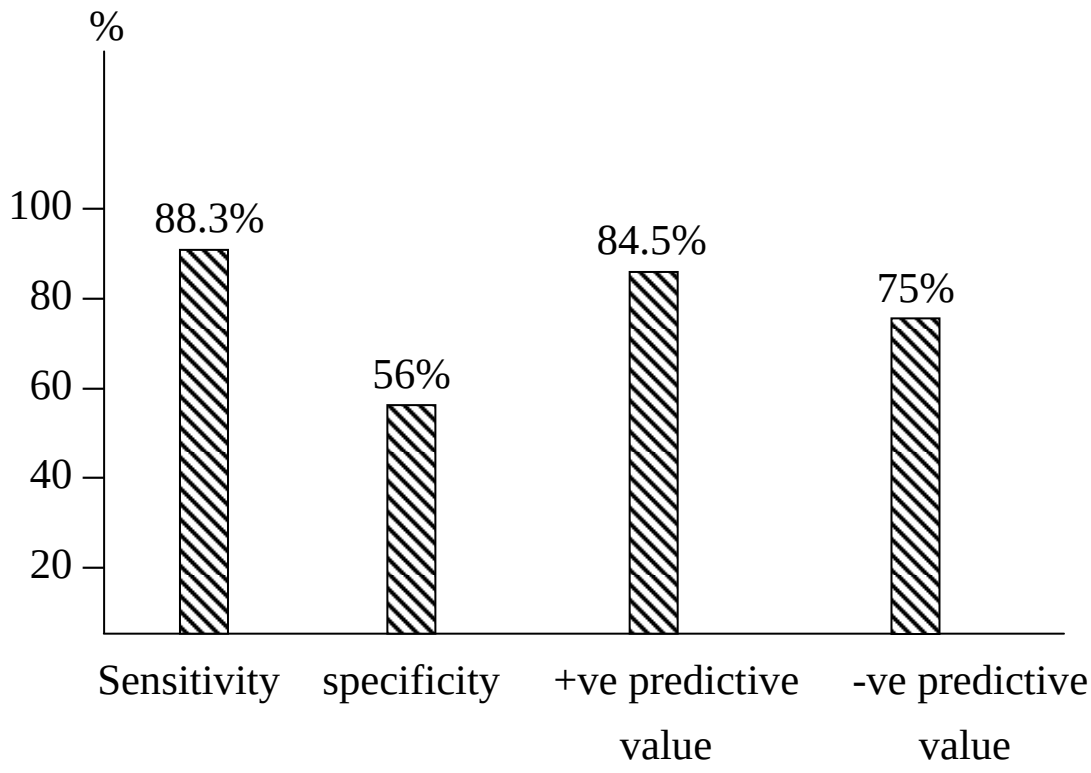

Figure "10" : show sensitivity, specificity, +ve predictive value, -ve predictive value of color Doppler to assess severity of MR.

Table (13) shows: - assessment of severity of MR. in the two groups of the study "rheumatic & congenital" by measuring vena contracta in cm

Vena contracta in cm	Congenital group	Rheumatic group
Mild	3 (30%)	4 (20%)
Moderate	6 (60%)	5 (25%)
Severe	1 (10%)	11 (55%)
Range	0.12-0.60	0.02-0.90
Mean	0.35	0.54
SD	0.14	0.28

t = 2.424, p = 0.022 (Significant)

- In the 20 patients of the rheumatic group the assessment of VC was ranging from (0.02 – 0.9 cm), their mean value was (0.54 ± 0.28 cm).

- In the 10 patients of the congenital group the assessment of VC was raging from (0.12 – 0.6 cm); their mean value was (0.35 ± 0.14 cm).

- The cut point for VC measurement were < 0.3 considered mild MR, ≥0.6 considered sever MR and in-between (0.3 to 0.6) considered moderate MR *(**Hall, et al 1997***)

Table (14) shows: - Sensitivity, specificity +ve protective value, -ve predictive value of vena contracta in comparison with pulsed Doppler.

Sensitivity	90%
specificity	65%
+ve protective value	89%
-ve predictive value	85%

- Sensitivity, specificity, +ve predictive value and –ve predictive value were calculated by comparison with quantitative pulsed Doppler assessment.

- Sensitivity was 90%, specificity was 65%, +ve predictive value was 89% and –ve predictive value was 85%.

Figure "11"

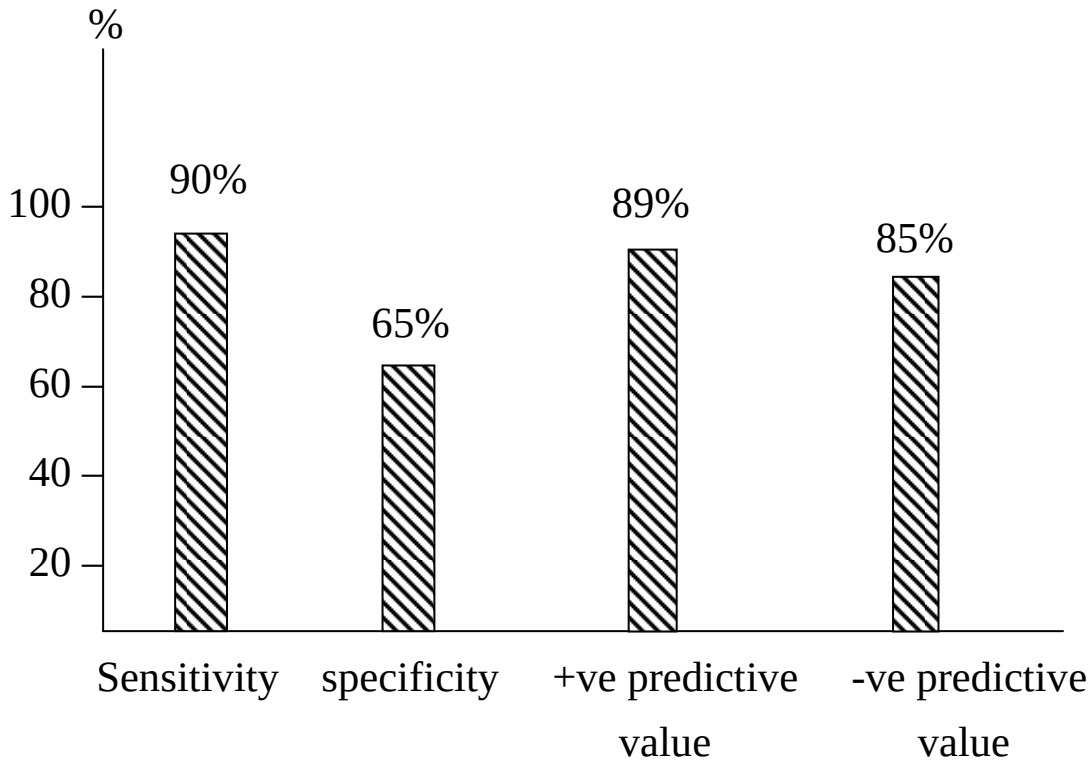

Figure "11": Show sensitivity, specificity, +ve predictive value, -ve predictive value of VC to assess mitral regurgess severity.

Table (15) shows: assessment of the severity of MR. Between the two groups of the study "congenital &rheumatic" by measuring flow propagation velocity

Flow propagation velocity (cm/sec)	Congenital group	Rheumatic group
Mild	1 (10%)	4 (20%)
Moderate	8 (80%)	3 (15%)
Severe	1 (10%)	13 (60%)
Range	21-51	12-90
Mean	35.60	49.50
SD	8.95	22.39

t = 2.417, p = 0.023 (Significant)

- In the 20 patients of the rheumatic group the assessment of RFPV (cm/sec) was ranging from (12 – 90 cm /sec) and their mean value was (49.5 ± 22.39 cm/sec).
- In the 10 patients of the congenital group of patients the assessment of RFPV (cm/sec) was ranging from (21- 51 cm /sec), their mean value was (35.6 ± 8.95 cm/sec).
- The cut point for RFPV were < 30 cm/sec considered mild MR, >50 cm/sec considered sever MR and in between (30 to 50 cm/sec) considered moderate MR(***Irvine,et al 2002***)

Table (16) shows: - Sensitivity, specificity +ve protective value, -ve predictive value of MRFPV in comparison of pulsed Doppler.

Sensitivity	95%
specificity	69%
+ve protective value	88%
-ve predictive value	96%

- Sensitivity, specificity, +ve predictive value and –ve predictive value were calculated by comparison with quantitative pulsed Doppler assessment.
- Sensitivity was 95%, specificity was 69%, +ve predictive value was 88% and +ve predictive value was 96%.

Figure "12"

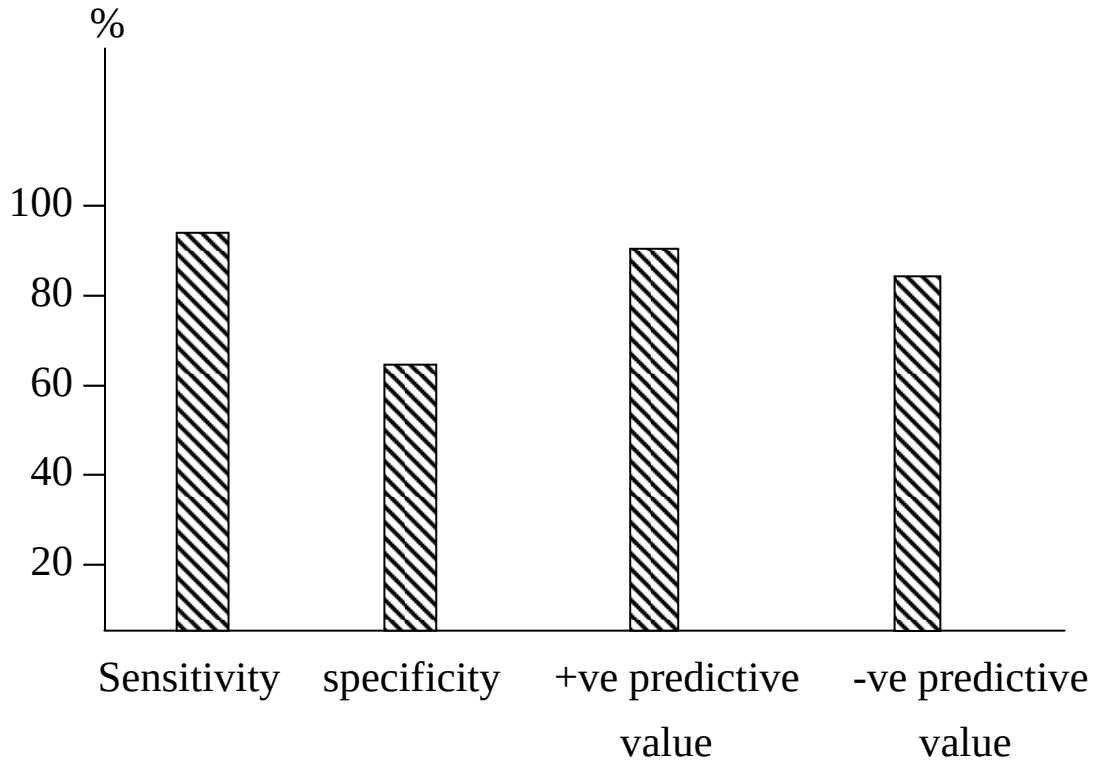

Figure "12": show sensitivity, specificity, +ve predictive value, -ve predictive value of FPV to assess severity of MR.

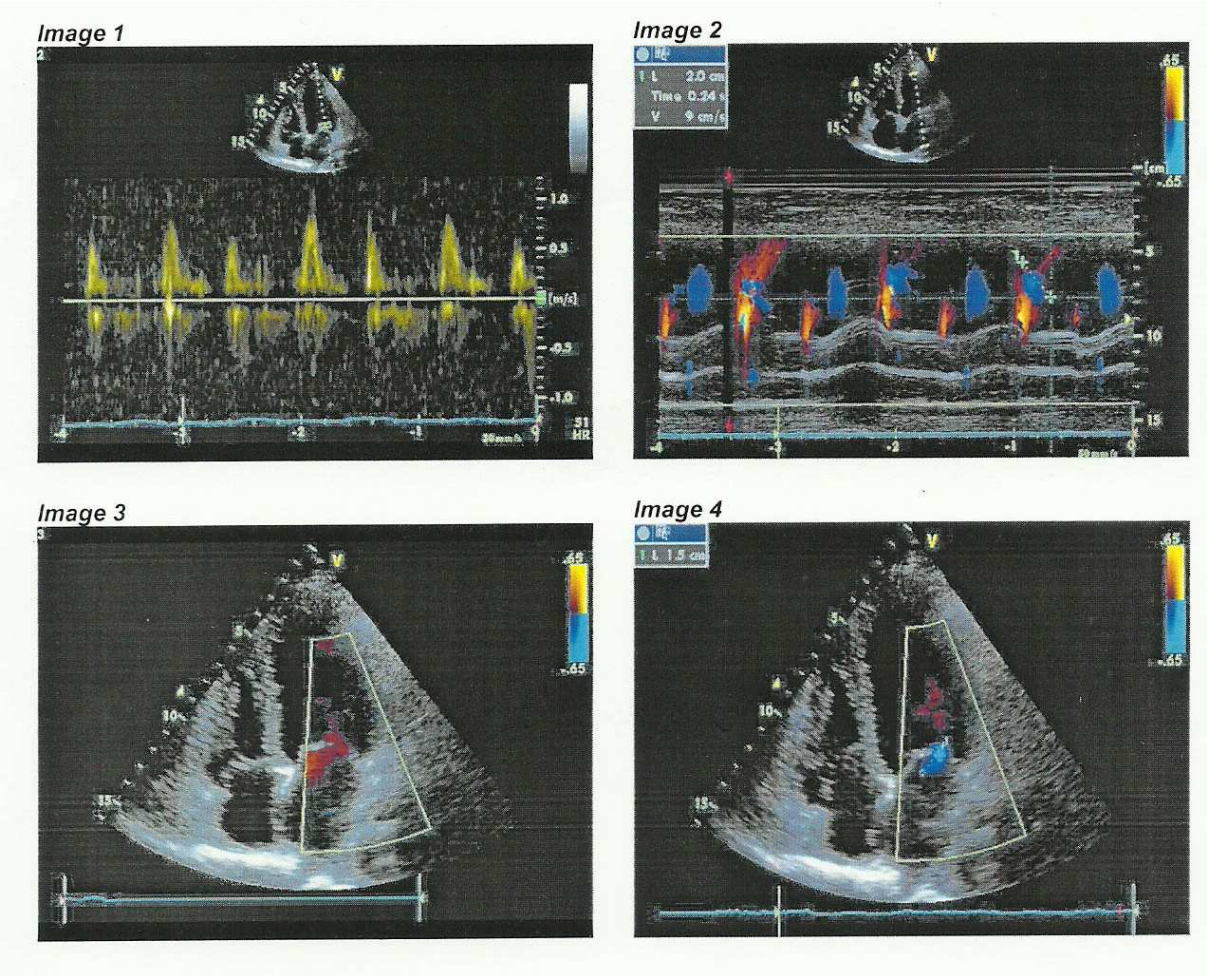

Figure (13): Representing a case of mild mitral regurge.

Image 1: Pulsed Doppler mitrl valve flow shows mild mitral regurge.

Image 2: Color M-mode flow propagation velocity measurement (9cm/sec) in the same case

Image 3: Apical four chamber view with colour Doppler shows vena contracta measurement (0.2 cm) in the same case.

Image 4: Apical four chamber view with color Doppler shows jet length measurement (1.5cm) and jet area (16%) in the same case.

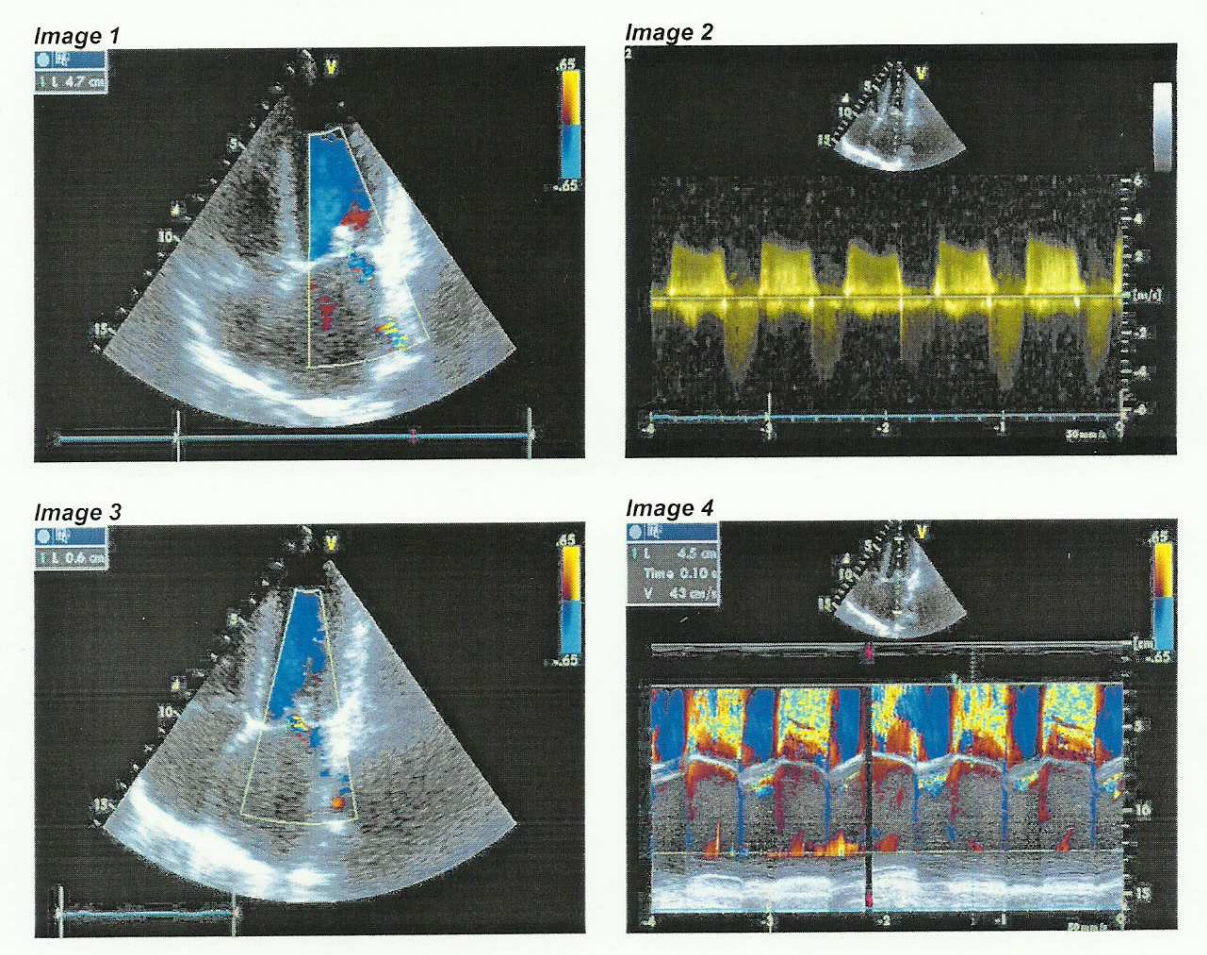

Figure (14): Representing a case of moderate mitral regurge.

Image 1: Apical four chamber view with color Doppler shows measurement of jet length (4.7cm) and jet area (42%).

Image 2: Continous Doppler mitral flow shows moderate to severe mitral regurge. in the same case.

Image 3: Apical four chamer view with color Doppler shows measurement of vena contracta (0.6cm) in the same case.

Image 4: Color M-mode mitral flow propagation velocity measurement (43cm/sec) in the same case.

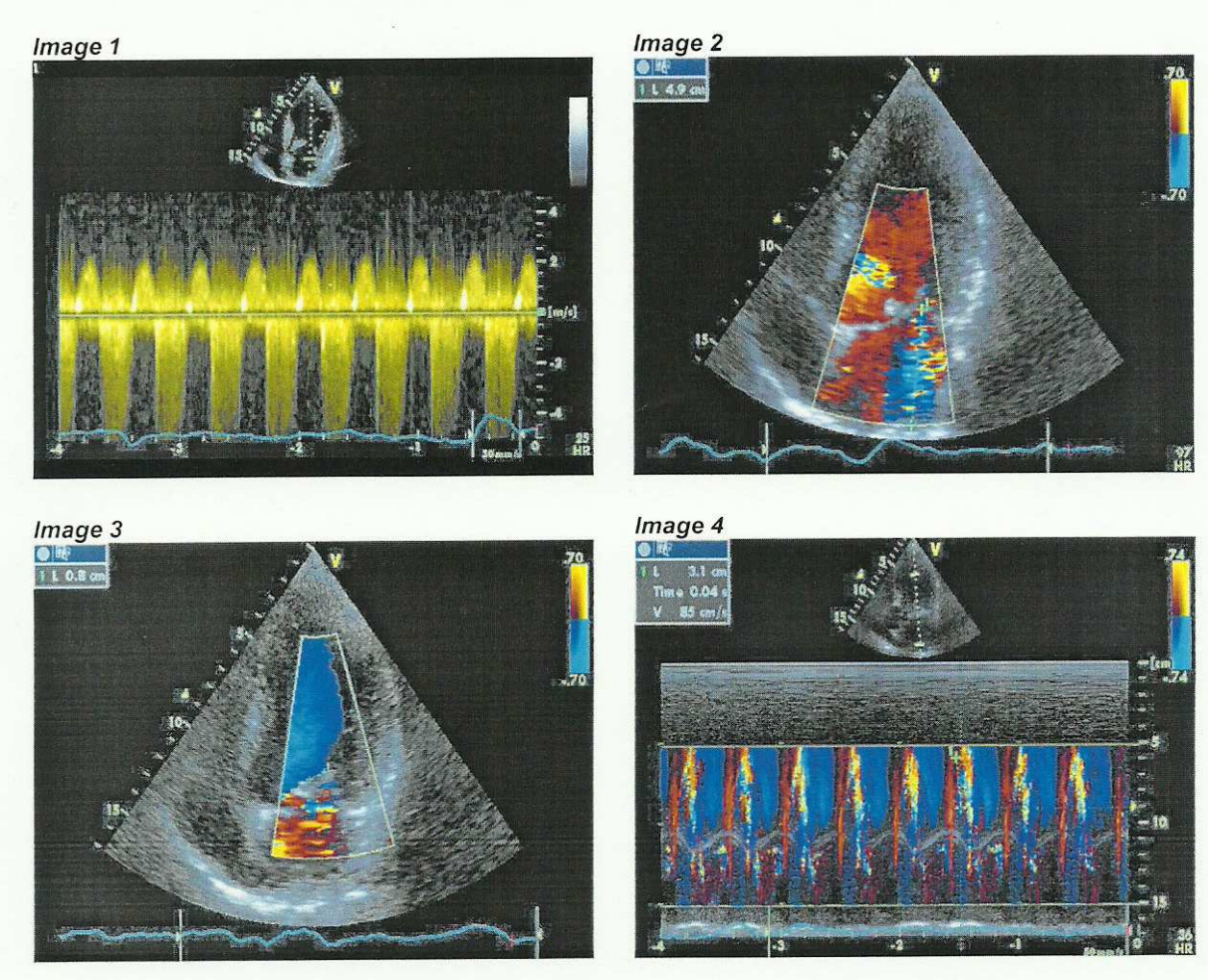

Figure 15: Representing a case of severe mitral regurge.

Image 1: Continous wave Doppler mitral flow shows severe mittral regurge.

Image 2: Apical four chamber view with color Doppler shows jet length measurement (4.9cm) and jet area (55%) in the same case.

Image 3: Apical four chamber view with color doppler shows vena contracta measurement (0.8cm) in the same case

Image 4: Color M-mode flow propagation velocity measurement (85cm/sec) in the same case.

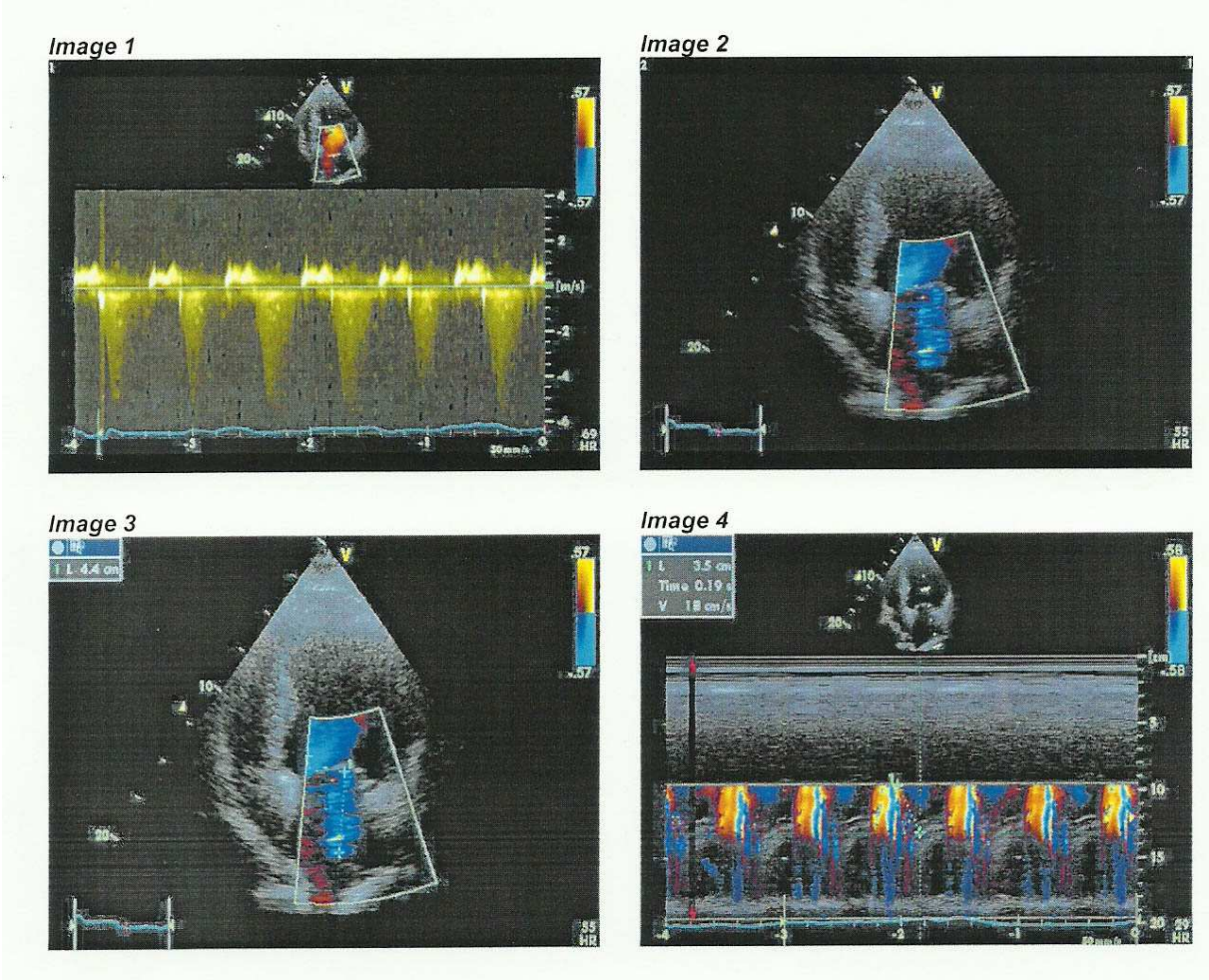

Figure 16: Representing a case of mild mitral regurge.

Image 1: Continous wave Doppler mitral flow shows mild to moderate mitral regurge.

Image 2: Apical four chamber view with color Doppler measurement of vena contracta (0.3cm) in the same case.

Image 3: Apical four chamber view with color Doppler measurement of jet length (4.4cm) and jet area (39%) in the same case.

Image 4: Color M-mode flow propagation velocity measurement (18cm/sec) in the same case.