Discussion
DISCUSSION

Despite considerable advances in medical diagnostics in recent past, status of cardiac function in malnutrition remains unclear. After much research work, most investigators now agree that in uncomplicated human and animal undernutrition cardiac atrophy occurs, and is in proportion to or slightly less than the loss in body weight.

In the present study the main aim was to study the cardiac involvement in severe malnutrition by various methods viz clinical, X-ray, ECG and ECHO.

To serve this aim a study group was taken comprising of thirty five children of severe malnutrition (PEM grade III and IV) according to IAP classification 1972, with age group varying from 6 month to 5 years. To compare the changes fifteen healthy children of same age group and sex matched were taken as controls (table-1). Both control group and study group were further classified according to sex into male and female subgroups (table-2). To compare the values of echocardiography between severe malnutrition (study group) and control group both group were further classified according to body surface area (table-3).

Clinical characteristics : Amongst the cases of PEM we observed that the most common complaint was of fever, loss of appetite and poor weight gain/weight loss (82% of cases). Other complaints were cough in 54% cases, diarrhoea in 48% cases, irritability/apathy in 34% cases, vomiting and edema in 20% cases. 17% cases had skin infections and ear discharge, adenitis was present in 11%, convulsions and abdominal pain in 5% and worm passage in 3% cases (table no.-4).
All the symptoms found in our study group were classical symptoms with which the patient with PEM commonly presents.

While considering the past history we observed recurrent diarrhoea to be very common in malnourished children. In our study it was present in 48% cases (table no.-5). 37% children had history of measles, 34% had history of recurrent ARI and 2% had history of whooping cough. This indirectly shows the wrong feeding habits of the population and increased tendency to have repeated GIT and RTI infections in malnourished children. Similarly, high incidence of measles cases indirectly shows poor immunization coverage of the population of this area.

Family history of tuberculosis or history of contact with TB was present in 10 cases (28%) (table-6). This shows the high prevalence of disease in the population and its risk in children especially malnourished one.

Immunization status (table-7) showed that BCG was given to 16 cases (45%), OPV to all 35 cases (100%), DPT to 10 cases (28%) and measles to only 2 cases (5%). Thus we observed the poor vaccination coverage of area especially for measles vaccine.

The developmental milestones were recorded in both group of cases. It was observed that they were delayed in 19 cases (54%) among which 30% belonged to grade IV PEM (14 cases) and 14% belonged to grade III PEM (5 cases) (table-8). Thus we observed more incidence of delayed milestones in PEM grade IV compared to PEM grade III.

Dietary evaluation was done in every case and we found inadequate dietary intake, in term of calories, proteins and fats.
All cases of PEM studied belonged to low socioeconomic status, had a rural background and low literacy level (table-9).

An attempt was also made to observe the various clinical signs in all the cases. Among clinical signs studied pallor was the most common finding present in all cases (100%). Also subcutaneous fat loss and muscle wasting were common findings and present in 32 cases (91%). Hair changes were present in 30 cases (85%), signs of vit B complex deficiency and vit A deficiency were present in 29 and 28 cases (82%, 80% respectively). Adenitis was present in 10 cases (28%) and edema was present in 7 cases (20% cases) (table –10).

Anthropometry was recorded in each and every case with special reference to weight for age, mid arm circumference and head circumference. Measurement of MAC showed that all cases had MAC of <12.5cm which revealed severe malnutrition (table-11). Measurement of head circumference in study group showed that 30 cases (85%) had normal head circumference i.e. more than 3rd percentile while 5 cases (15%) had microcephaly. Among these 5 cases, 3 cases belonged to PEM grade IV and 2 belonged to grade III PEM (table –12).

A detailed systemic examination was also conducted in all the cases. In respiratory system we observed the signs and symptoms of RTI in 19 cases (54%). In GI system, hepatomegaly was present in 10 cases (28%) and splenomegaly in 8 cases (23%). In CNS examination, 24 cases showed hypotonia, which shows increase tendency of decreased tone in PEM due to muscular wasting. Psychomotor changes were present in 12 cases, irritability in 7 cases, apathy in 5 cases, convulsions were present in 2 cases while tremor in one case (table-13).
In cardiovascular findings (table-14), Heart rate showed general tendency towards sinus tachycardia. In our study 68% cases in study group had heart rate more than normal heart rate. The mean heart rate in study group was 122±16/min and in controls was 106±12/min which was significantly higher. This finding was consistent with the studies of Gopalan et al 1955, Smythe PM et al 1962, Khalil M et al 1969, Singh GR et al 1989, Olowanyo MT et al 1993. They also found tachycardia frequently in malnourished children. Khalil and Smythe reported increased heart rate in more than 90% of their cases while, Gopalan et al 1955 reported it in only 33% cases. Singh GR et al 1989 observed tachycardia in all cases. None of our cases had bradycardia, however Keys and coworkers 1950 and Smythe and Gopalan reported bradycardia in 3% and 14% in their series respectively.

Other clinical findings like decreased pulse volume, decreased peripheral perfusion, increased capillary filling time and cold extremities were found in 5% cases (2 cases out of 35). These clinical findings suggest that there is low cardiac output state in some malnourished children, while in most cases compensatory mechanisms like tachycardia, decreased activity etc. comes to play and maintains cardiac index. These findings were consistent with the findings of Smythe et al 1962, Brooke et al 1973, Alden Peter B et al 1987. Thus our study supported the fact that there is low cardiac output state present in severely malnourished children due to small heart, diminished left ventricular functions and decreased oxygen demand because of metabolic adaptation of body in malnutrition.
Haemoglobin level in the study group was found to be lower in comparison to controls. The mean haemoglobin level in study group was 8.6±1.2gm% and in controls it was 9.9±0.8gm% (table-15).

S. albumin level in study group was also found lower in comparison to controls. The mean serum albumin level in study group was 3.0±0.30 gm/dl and in controls the mean level was 4.10±0.21gm/dl (table-16). Thus there was a significant (p<0.02) lower values of S. albumin in severely malnourished children in comparison to controls. Phornphatkul et al (1994) found decreased mean S. albumin level in severely malnourished children, Kothari et al 1992 also found low S. albumin levels in 60% of patients.

Mean S. Sodium level in control group was 140.3±2.4meq/L and in study group the mean level was 139.2±3.5meq/l, thus there was no significant (p>0.05) difference between means (table-17). Singh GR et al 1989, Kothari et al 1992 also had not found any significant change in serum sodium levels in their study.

Mean serum potassium level observed in our study was lower in study group than in controls. In study group it was 3.6±0.21 meq/L while in controls it was 4.2±0.46meq/L. Thus there was significant (p<0.01) lower values of S. potassium in severely malnourished children as compared to controls (table-18). However, there was no such difference in the studies by Singh GR et al 1989 and Kothari et al 1992, but Phornphatkul et al 1994 found S. potassium level to be in lower range in comparison to controls in malnourished children. Mann MD et al 1975 also found that total body potassium is almost always low in severely malnourished children and hyponatremia is also common.
Cardiothoracic ratio, which is maximum transverse diameter of cardiac shadow on chest radiograph was used as an index of heart size (table-20). In our study the CT ratio was less than 50% in 90% of children in study group. The mean value in study group was 46.8±1.8%, while in controls it was 51.6±2.1%, thus there was significant (p<0.001) decrease in CT ratio in cases as compared to controls. Workers like Czerny et al (1914) Smythe et al (1962), Heymsfield et al (1978), Bergman et al (1988), Singh et al (1989), Olowanyo MT et al (1993), Olowanyo MT et al (1995) also found decreased cardiothoracic ratio in severely malnourished children.

Smythe et al 1962 found that, in only 7 out of 56 cases of their study, the CT ratio lied within 2 SD, rest had a significant smaller size of heart when compared to controls. Bergman et al 1988 had chest radiography of all 21 cases studied and found that cardiothoracic ratio was below 60% in all. Twenty out 21 (95%) had ratios less than 55% and 18 of 21 had values less then 49%.

Singh GR et al 1989 found mean Cardiothoracic ratio to be 46.76% in severly malnourished children and 49.12% in controls. Kothari et al 1992 in their study of 25 children, found CT ratio of less than 0.4 in 10 patients with malnutrition (40%) despite low haemoglobin levels.

Olowanyo MT et al (1993) found cardiothoracic ratio of less than 50% in 53% of their study group. They observed mean(SD) Cardiothoracic ratio of 49.39 (4.0) (range:41-63%) in patients with kwashiorkor, which was significantly lower than in the controls, whose mean (SD) ratio was 55.4 (3.5) (range 51-60%) (p<0.0001). Olowanyo MT et al 1995 also found decreased mean Cardiothoracic ratio (48.6±3.4%) in malnourished cases,
which were significantly smaller than controls (54±3.2%) (p<0.001). Hence, our findings are consisting with the findings of above workers.

Electrocardiographic changes were studied in all cases of severe malnutrition (table-19). We observed sinus tachycardia in most cases, increased heart rate was found in 68% cases of study group. The mean HR/min in study group was 122±16/min while in controls it was 106±12/min. Our observation reveals that there was a significant increase in heart rate in study group (p<0.05) as compared to controls. This finding is consistent with findings of Khalil et al 1969, Smythe PM et al 1962, Singh GR et al 1989, Gopalan et al 1955, Olowanya MT et al 1993. But Keys and coworkers 1950 and Smythe et al 1962 and Gopalan et al 1955 also reported bradycardia in 3% and 14% respectively in their series.

Generalized low voltage of P wave and QRS complex were observed in malnourished children (study group) (table 21,22,23). The amplitude of P wave was decreased by 20% in study group as compared to controls. The mean amplitude of P wave in study group was 1.21±0.23mm and in controls it was 1.53±0.12mm. Thus, there was a significant decrease in P wave amplitude in severe malnutrition cases (p<0.01) (table –21).

Mean R wave amplitude was also 40% decreased in study group as compared to controls (table-22). The mean value was 11±1.9mm in study group while in controls it was 19±2.8mm. Thus, there was significant decrease in severe malnutrition cases (p<0.001).

Mean value of S wave amplitude in study group was 12±1.7mm and this value was 42% less than that of controls (mean 20±2.9mm) (table-23).
Thus, there was a significant reduction in amplitude of S wave in study group as compared to controls (p<0.001).

No significant changes were found in T wave and ST segment between study group and controls.

Thus electrocardiographic study which was done in all the cases was suggestive of increased heart rate, decreased amplitude of P wave and QRS complexes. There was normal rhythm and no significant changes were observed in T wave and ST segment between study group and controls. Our findings were similar to the findings observed by Gopalan et al (1955), Smythe et al (1962), Bergman JW et al (1988), Singh GR et al (1989), Olowayo MT et al (1993), Olowayo MT et al (1995), EL Sayed HL et al (2006). They also observed decreased amplitudes of P wave and QRS complexes in severely malnourished children.

Gopalan et al 1955 found marked reduction in amplitudes of P wave, QRS complexes in all the leads and in all cases. They observed markedly subnormal P wave and QRS complexes. They found P wave amplitude not exceeding 0.5mm in malnourished cases.

Smythe et al 1962 observed sinus tachycardia, heart rate upto 200/min, low P and QRS voltages in malnourished children. QRS voltages was below 1.5mv in 80 cases out of 91 cases studied. 49 cases had voltage less than 1mv. Bergman JW et al 1988 observed diminished amplitude in malnourished cases. They found that amplitude of R wave in $V_6$ was less than 25th centile (as compared with age related centiles) in 18 out of 19 patients and less than 5th centile in seven (37%) cases. Singh GR et al 1989 also observed low amplitude of P wave and QRS waves along with
sinus tachycardia. They observed that heart rate increases with increased severity of malnutrition. In their study, they found significant increase over 40-50% in heart rate compared to the mean control value.

Olowanyo et al 1993 observed sinus tachycardia and significant lower values of amplitude of P and QRS waves in malnourished children as compared to controls (p<0.001). The mean (SD) heart rate in their study group was 121 (23) beats/min was significantly higher than that of controls (p<0.001) where mean (SD) value was 96(16) beats/min.

Study by EL Sayed et al 2006 in malnourished children also found significant decrease in amplitudes of P waves and QRS waves as compared to controls. Hence our ECG findings are consistent with the work of above research workers.

Echocardiographic findings: M mode echocardiography was done in all cases and controls to assess the cardiac size and cardiac function in severe malnutrition. We assessed interventricular septal thickness (IVS), left ventricular internal dimensions (LVID), left ventricular posterior wall thickness (LVPWT) and ejection fraction in all cases of study group and controls and then compared them.

IVS thickness (systole) and IVS thickness (diastole) in controls measured 0.62±0.02cm and 0.44±0.03cm respectively, while in study group it was 0.54±0.03cm, and 0.40±0.02cm respectively. There was 12.9% decrease in thickness of IVS in systole and 9% decrease in diastole. Thus, there was significant decrease found (p<0.001) in severely malnourished children (study group).
LVID (systole and diastole) in control group came to be 1.9±0.19cm, 2.8±0.24cm and 1.5±2.1cm, 2.4±1.8cm respectively. There was 21% decrease in LVID in study group during systole and 14.8% decrease during diastole which came to be statistically significant (p<0.001).

LVPWT (systole and diastole) values measured as 0.64±0.03cm and 0.45±0.01cm in study group and 0.58±0.04cm and 0.40±0.03cm in controls. Here also a significant decrease was observed with 9% decrease in LVPWT during systole and 11% decrease during diastole (p<0.001).

Ejection fraction is the measurement of left ventricular function and it was studied in all cases and controls. A significant difference was observed in EF between cases and controls (P<0.05). EF in controls was 70±3.4% and in study group it was 63.7±5.2%. There was 9.3% decrease in value in study group as compared to controls.

All of the above ECHO measurements were observed to be significantly decreased in severely malnourished children than normal children. Our finding are similar to the studies of Bergman JW et al, 1988, Singh GR et al 1989, Phornphatkul et al 1994, Olowanyo MT et al 1995, Ocal B et al 2001, which was also suggestive of decreased cardiac chamber size, decreased IVS and LV posterior wall thickness and impaired LV systolic function viz EF of heart.

Bergman JW et al 1988 observed significant decreased cardiac dimensions and ventricular wall measurements in their study by M Mode echo. They observed that, 17 out of 21 patients (81%) had values below 5th centile for IVS measurement and 15(71%) for LVPW thickness.
Singh GR et al 1989 also observed significantly decreased cardiac dimensions, left ventricular function viz ejection fraction in their study of severely malnourished children. The ejection fraction values were decreased upto 54.31% in severely malnourished children compared to controls.

Phornphatkul et al 1994 observed decreased septal wall thickness in 8 out of 11 children at end systole and in 3 children at end diastole LVPW thickness was observed below 5th percentile during systole in 10 children and in 9 children during diastole.

Kothari et al 1992 however did not observe any significant difference in ejection fraction (p>0.05). Ocal B et al 2001 also did not find any significant difference in ejection fraction (p>0.05), instead they found significant decrease in LV septal and posterior wall thickness and LV mass.

Recent studies by Olivares JL 2005 by Echocardiography observed significant decrease of LV mass in malnourished children (LVm 55.3±10.3 vs 71.3±6.9).

EL Sayed HL et al 2006 in their study observed marked decrease in cardiac dimensions in malnourished children and found that systolic function of the heart viz ejection fraction is affected more than the diastolic function but these changes manifest only in severe cases. Hence our ECHO findings corroborate with the ECHO findings of the above workers.