EVALUATION OF CARDIAC CHANGES IN ACUTE POST STREPTOCOCCAL GLOMERULONEPHRITIS CHILDREN

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ABSTRACT

Background: The commonest type of childhood glomerulonephritis is acute post-streptococcal glomerulonephritis (APSGN). Cardiac dysfunction has been proven by many studies in chronic renal diseases but only scanty data available about cardiac dysfunction in children with APSGN.

Aim of the study: To evaluate cardiac affection in children with APSGN using ECG, conventional echocardiography as well as tissue Doppler imaging in addition to serum NT-proBNP levels.

Subject and Methods: This was a comparative longitudinal observational study was conducted on forty children aged 2 – 15 years were selected and classified into two groups; group (I) constitutes 20 patients diagnosed as APSGN (cases) and group (II) constitutes 20 normal children matched with group I in age and sex, and used as control. All children included in the study were subjected to complete history taking, physical examination and investigations including urinalysis, kidney function, ASOT, ESR, CRP, C3, NT-ProBNP, Echocardiography and Tissue Doppler Imaging (TDI). Follow up for cases after six weeks by echocardiography, TDI and NTproBNP.

Results: There was a statistically significant increase of QTc interval among cases of APSGN in comparison to control group. There was a statistically significant increase in measurements of LA, LVEDd and LA/AO in cases as compared to controls with statistically significant decrease in PW as compared to controls. There was a statistically significant decrease as regard A' and E'/A' ratio in cases in comparison to controls.

Conclusions: We concluded that cases with acute post streptococcal glomerulonephritis showed left ventricular dilatation and hypertrophy (Increase in the left ventricular end-diastolic diameter and wall thickness). NT-proBNP is a helpful biomarker in diagnosis of cardiac affection in cases with APSGN and had statistically significant positive correlation between NT-proBNP and SBP, DBP, QTc, E, E/A ratio, MPA,RPA,LPA, PLT, urea, Cr, K, CRP, ASOT in cases of APSGN during the acute stage. that there is statistically significant positive correlation between NT-proBNP and E/E' ratio in cases of APSGN during the acute stage, while there is statistically significant negative correlation between NT-proBNP and A', E' in cases of APSGN during the acute stage. Significant association was found and agreement of NT-proBNP cutoff and cases. There was significant decrease as regard QTc, E, E/A ratio, LA, LA/AO ratio in cases of APSGN after six week follow up in comparison to the results during the acute stage while there is significant increase as regard IVS, LVEDd and A' in cases after six weeks follow up in comparison to the results during the acute stage.

Keywords: acute post-streptococcal glomerulonephritis (APSGN), Cardiac dysfunction.
I. INTRODUCTION

A common infectious agent in childhood is group A streptococcus (GAS) which is responsible for a wide range of clinical diseases in humans. These diseases are classified into toxin mediated, superficial, invasive and post-infectious diseases. Auto-immune post-infectious sequelae of GAS, acute post-streptococcal glomerulonephritis and acute rheumatic fever are responsible for most of related mortality and morbidity (1).

The commonest type of childhood glomerulonephritis is acute post-streptococcal glomerulonephritis (APSGN) which is characterized by acute onset of hypertension, gross or microscopic hematuria, edema and acute renal insufficiency and is more common in age group (2-15) years (2).

Multiple organs can be affected by APSGN including the heart. Very few studies have cardiac status evaluated in children with acute post-streptococcal glomerulonephritis; cardiac complications in children with APSGN can be the presenting feature and may develop during the disease course. Renal failure, electrolyte imbalance and hypertension are leading causes to fluid retention which is precipitating factor for congestive cardiac failure (CCF) that can occur in 15 to 50% children with APSGN leading to apparent morbidity and rarely death (3).

Cardiac dysfunction has been proven by many studies in chronic renal diseases but only scanty data available about cardiac dysfunction in children with APSGN (4,5).

Left ventricular hemodynamics were studied by Kamisago and Hirayama using pulsed Doppler and M-mode echocardiography on 18 children with APSGN. During acute stage of PSGN, left ventricular afterload, preload and contractility were increased essentially as a result of hypervolemia (6).

In the presence of overt ventricular dysfunction, the conventional echocardiography parameters are usually altered. Tissue Doppler imaging (TDI) modalities including tissue velocity imaging (TVI) and strain imaging (SI) may prove useful in early detection of regional myocardial dysfunction before the occurrence of abnormal indices of global ventricular function (7).

Brain natriuretic peptide (BNP) is a cardiac natriuretic peptide hormone that is produced in both the brain and the heart (8,9). Its prohormone, proBNP, is cleaved to a biologically active form of BNP and an inactive N-terminal proBNP peptide (NT-proBNP). The inactive NT-proBNP can be detected and measured in the circulation (10).

During heart failure BNP is involved in fluid and electrolyte homeostasis and is secreted predominantly from the ventricular myocardium. BNP released from ventricular myocytes as a result to Myocyte stretch, increased end-diastolic pressure and volume in the left ventricle (LV) (11).

Left ventricular volume overload is associated with Higher NT-proBNP concentrations as reported previously by different studies (12,13 and14).

We aimed in this study to evaluate cardiac affection in children with APSGN using ECG, conventional echocardiography as well as tissue Doppler imaging in addition to serum NT-proBNP levels.

II. STUDY DESIGN AND PARTICIPANTS

This was a comparative longitudinal observational study was conducted on forty children aged 2 – 15 years were selected and classified into two groups; group (I) constitutes 20 patients diagnosed as APSGN (cases) and group (II) constitutes 20 normal children matched with group I in age and sex, and used as control. Well-informed verbal and written parental consent from every case or their caregivers that participates in this research was taken. This study was ethically approved from, Institutional Reviewer Board (IRB) in Faculty of Medicine, Zagazig University Hospital.

The total sample include 40 child classified in to two groups.

Group 1 (case group): The target sample comprised 20 patient of age range (2-15 years) selected from those admitted to the pediatric nephrology unit and well diagnosed as having APSGN during acute stage which was defined as acute onset of edema, oliguria, and hematuria (gross or microscopic) with antecedent streptococcal infection as indicated by either a history of sore throat or pyoderma and raised antistreptolysin O titre ASOT < 200 todd units.

Group 2 (control group): including 20 apparent healthy children, matched with group 1.
in their age and sex.

**Inclusion criteria:**
- All children are between 2-15 years of age.
- Both sexes are included.
- Patients diagnosed with APSGN during acute stage, all are hypertensive with hematuria.

**Exclusion criteria:**
- Age above 15 years.
- Patients not in the acute stage of the disease.
- Non-hypertensive patients even they were in the acute stage of the disease.
- Any patients with pre-existing cardiac problems (cardiomyopathy, congenital or rheumatic heart disease) or chronic renal problems.
- Any patient with disease increasing BNP like heart failure and cardiomyopathy

**Patients were subjected to the following:**

**Full history taking:** including personal, complaint, past and family histories.

**General Examination**

**Local examination**
Chest examination: For signs and degree of respiratory distress by assessment of chest retractions, grunting and working accessory muscles. Cardiac Examination: for Auscultation of the heart sounds and detection of any congenital heart diseases or signs of heart failure or murmurs.

All patients and control were subjected to **echocardiography** for evaluation of the following:
- Conventional echocardiographic assessment for left ventricular systolic function (ejection fraction & fraction of shortening), and diastolic left ventricular function assessment.
- LV mass and relative wall thickness (RWT).
- Tissue Doppler velocity imaging for mitral annular tissue velocity.
- All patients and controls were subjected to **laboratory study and ECG**.

**Baseline investigations:**
- **Urine analysis:** (Random urine sample collected for routine urine analysis, microscopic examination using Olympus CH2 and Biochemical examination using Combi-10)
- **CBC.** (2 ml of blood on EDTA for CBC using Sysmex-Xs 500 – Germany)
- **Kidney functions for:** BUN & serum creatinine by automated auto-analyzer COBAS 8000
- **C-Reactive Protein** (CRP): by automated auto-analyzer COBAS c 501
- **Anti-Streptolysin O Titer** (ASO Titer): by automated auto-analyzer COBAS c 501
- **Complement 3** (C3) : by automated auto-analyzer COBAS c 501
- For all blood investigations a 4 ml of blood collected from the patient and divided in to 2ml of blood on serum plain Vacutainer for biochemical analysis, 2ml of blood on plain Vacutainer and serum was separated, aliquoted and kept on -80°C for further measurements of NT-proBNP
Special investigations:

- Plasma levels of N-terminal pro BNP.

Measurement of NT-proBNP:

Plasma levels of NT-Pro BNP was measured in patients and control groups using a research NT-Pro BNP enzyme linked immunosorbent assay (ELISA) kit (Shanghai Sunred Biological Technology Co., Ltd. catalog No:201-12-1240; China). The personnel performing the assay was blinded to both the clinical and echocardiographic results.

- All cases were under follow up program after six weeks by applying ECG, Echocardiography and NT-ProBNP to evaluate the cardiac status after six weeks and after completing the course of management.

Statistical Analysis:

Data collected throughout history, basic clinical examination, laboratory investigations and outcome measures coded, entered and analyzed using Microsoft Excel software. Data were then imported into Statistical Package for the Social Sciences (SPSS version 20.0) (Statistical Package for the Social Sciences) software for analysis. According to the type of data qualitative represent as number and percentage, quantitative continues group represent by mean ± SD, for parametric data median (range) for non-parametric data the following tests were used to test differences for significance; Difference and association of qualitative variable by Chi square test (X2). Differences between quantitative independent groups by t test or Mann Whitney, paired by paired t or sign. Spearman’s correlation was performed, ROC curve analysis was used to identify best cutoff value for BNP with max sensitivity and specificity with agreement by Kappa. P value was set at <0.05 for significant results &<0.001 for high significant result.

III. RESULTS

Mean age in case group was 7.47±1.54 years with mostly 65 % females while mean age in control group was 8±0.78 years also with predominance of female 65%. All patients (100 %) had edema, hypertension, hematuria, 35 % had oliguria, 15 % had convulsions, and 10 % had encephalopathy. Systolic blood pressure (SBP), Diastolic blood pressure (DBP), RBC and protein in urinewere significantly higher among cases of APSGN than controls (137.0±9.23, 87.0±5.71, 40(15-100), 45% versus 108.25±5.91, 67.0±6.36, 4(2-6) and 0.0% respectively).

There was a statistically significant increase of QTc interval among cases of APSGN in comparison to control group. 9 patients (45%) out of 20 patients presented with prolonged QTc (Table 1).

There was a statistically significant increase in measurements of LA, LVEDd and LA/AO in cases as compared to controls with statistically significant decrease in PW as compared to controls. There is no statistically significant difference between cases and controls as regard AO, IVS and LVESd (Table 2).

There was a statistically significant decrease as regard A’ and E'/A’ ratio in cases in comparison to controls, while no significant difference regarding S’ and E’ velocities among studied groups (Table 3).

There was a statistically highly significant increase in NT-proBNP levels in cases of APSGN in comparison to control group (Table 4).

There was a statistically significant positive correlation between NT-proBNP and PLT, urea, Cr, K, CRP, ASOT in cases of APSGN during the acute stage, while there is statistically significant negative correlation between NT-proBNP and Na, C3 in cases of APSGN during the acute stage (Table 5).

There was a statistically significant positive correlation between NT-proBNP and E/E’ ratio in cases of APSGN during the acute stage, while there is statistically significant negative correlation between NT-proBNP and A’, E’ in cases of APSGN during the acute stage (Table 6). There was a significant association and agreement of NT-proBNP cutoff and cases (Table 7).

There was a significant decrease as regard QTc, E, E/A ratio, LA, LA/AO ratio in cases of APSGN after six week follow up in comparison to the results during the acute stage while there was significant increase as regard IVS, LVEDd and A’ in cases after six weeks follow up in comparison to the results during the acute stage. Also there is no statistically difference as regard A, MPA, RPA, LPA, AO, PW, LVESd, EF%, FS%, S’, E’, and E’/A’ ratio in cases after six weeks follow up in comparison to the results during the acute stage (Table 8).
Table 1: The QTc in cases of APSGN in comparison to controls:

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Case (N=20)</th>
<th>Control (N=20)</th>
<th>t</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>QTc (X±SD)</td>
<td>0.44±0.09</td>
<td>0.35±0.019</td>
<td>4.025</td>
<td>0.00**(HS)</td>
</tr>
</tbody>
</table>

QTc: corrected QT interval

Table 2: M-mode Echocardiographic left sided measurements in patients with APSGN in the acute period in comparison to control group:

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Case (N=20)</th>
<th>Control (N=20)</th>
<th>t</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>AO (mm)</td>
<td>21.8±2.72</td>
<td>21.07±3.53</td>
<td>0.726</td>
<td>0.08 (NS)</td>
</tr>
<tr>
<td>(X±SD)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LA (mm)</td>
<td>36.11±9.89</td>
<td>25.41±3.41</td>
<td>4.575</td>
<td>0.02 (S)*</td>
</tr>
<tr>
<td>(X±SD)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LA/AO (ratio)</td>
<td>1.64±0.51</td>
<td>1.18±0.14</td>
<td>3.832</td>
<td>0.02 (S)*</td>
</tr>
<tr>
<td>(X±SD)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IVS (mm)</td>
<td>6.68±2.26</td>
<td>7.3±1.98</td>
<td>-0.928</td>
<td>0.71 (NS)</td>
</tr>
<tr>
<td>(X±SD)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PW (mm)</td>
<td>8.14±1.96</td>
<td>10.84±1.82</td>
<td>4.516</td>
<td>0.01 (S)*</td>
</tr>
<tr>
<td>(X±SD)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LVEDd (mm)</td>
<td>40.38±4.32</td>
<td>36.67±4.89</td>
<td>-0.884</td>
<td>0.003(S)*</td>
</tr>
<tr>
<td>(X±SD)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LVESd (mm)</td>
<td>25.93±4.29</td>
<td>22.86±3.59</td>
<td>2.458</td>
<td>0.31 (NS)</td>
</tr>
<tr>
<td>(X±SD)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 3: Tissue Doppler velocities of lateral mitral annulie among studied groups

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Case (N=20)</th>
<th>Control (N=20)</th>
<th>t</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>S' (cm/s) lateral (X±SD)</td>
<td>6.7±0.1</td>
<td>6.8±0.06</td>
<td>0.37</td>
<td>0.86 (NS)</td>
</tr>
<tr>
<td>E' (cm/s) lateral (X±SD)</td>
<td>8±0.3</td>
<td>12.6±0.02</td>
<td>2.37</td>
<td>0.04*(S)</td>
</tr>
<tr>
<td>A' (cm/s) lateral (X±SD)</td>
<td>7±0.2</td>
<td>7.6±0.16</td>
<td>0.11</td>
<td>0.41 (NS)</td>
</tr>
<tr>
<td>E'/A' ratio (X±SD)</td>
<td>1.12±0.26</td>
<td>1.71±0.37</td>
<td>7.55</td>
<td>0.001** (HS)</td>
</tr>
</tbody>
</table>

Table 4: NT-proBNP levels in cases of APSGN in comparison to controls

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Case (N=20)</th>
<th>Control (N=20)</th>
<th>MannWhitney</th>
</tr>
</thead>
<tbody>
<tr>
<td>NT pro BNPPg/ml Median(range)</td>
<td>207.4(0.42-695)</td>
<td>50.12(1-72)</td>
<td>5.161</td>
</tr>
</tbody>
</table>

Table 5: Correlation Between NT-proBNP and Laboratory parameters in cases with APSGN during the acute stage

```plaintext
<table>
<thead>
<tr>
<th>Characteristics</th>
<th>NT pro BNp</th>
<th>Characteristics</th>
<th>NT pro BNp</th>
</tr>
</thead>
<tbody>
<tr>
<td>HB P</td>
<td>-.058</td>
<td>Na R</td>
<td>-.659</td>
</tr>
<tr>
<td>R</td>
<td>.722</td>
<td>R</td>
<td>.000</td>
</tr>
<tr>
<td>RBCs R</td>
<td>-.102</td>
<td>K R</td>
<td>.620**</td>
</tr>
<tr>
<td>P</td>
<td>.532</td>
<td>R</td>
<td>.000</td>
</tr>
<tr>
<td>C3</td>
<td>.352</td>
<td>R</td>
<td>-.519**</td>
</tr>
<tr>
<td>Platelets P</td>
<td>.026</td>
<td>P</td>
<td>.001</td>
</tr>
<tr>
<td>Urea R</td>
<td>.435**</td>
<td>CRP R</td>
<td>.396*</td>
</tr>
<tr>
<td>P</td>
<td>.005</td>
<td>P</td>
<td>.011</td>
</tr>
<tr>
<td>Cr R</td>
<td>.143</td>
<td>ASOT R</td>
<td>.412**</td>
</tr>
</tbody>
</table>
```
Table 6: Correlation Between NT-proBNP and Tissue Doppler echocardiographic parameters in cases with APSGN during the acute stage:

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>NTpro BNp</th>
<th>Characteristics</th>
<th>NTpro BNp</th>
</tr>
</thead>
<tbody>
<tr>
<td>S' R</td>
<td>.293</td>
<td>E'/A' R</td>
<td>-.048</td>
</tr>
<tr>
<td>P</td>
<td>.066</td>
<td>E/E' R</td>
<td>.771</td>
</tr>
<tr>
<td>R</td>
<td>-.330*</td>
<td>P</td>
<td>.412**</td>
</tr>
<tr>
<td>E' P</td>
<td>.038</td>
<td>A' R</td>
<td>.009</td>
</tr>
<tr>
<td>P</td>
<td>.000</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 7: Association and agreement of NT-proBNP cutoff and cases:

<table>
<thead>
<tr>
<th>Group</th>
<th>Control</th>
<th>Case</th>
<th>Total</th>
<th>X²</th>
<th>P</th>
<th>Kappaagreement</th>
</tr>
</thead>
<tbody>
<tr>
<td>NT-proBNPPg/ml</td>
<td>&lt;55.3 N</td>
<td>14</td>
<td>2</td>
<td>16</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>%</td>
<td>70.0%</td>
<td>10.0%</td>
<td>40.0%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt;55.3 Pg/ml</td>
<td>N 6</td>
<td>18</td>
<td>24</td>
<td>15.0</td>
<td>0.00**</td>
<td>0.61</td>
</tr>
<tr>
<td></td>
<td>% 30.0%</td>
<td>90.0%</td>
<td>60.0%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>N 20</td>
<td>20</td>
<td>40</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>% 100.0%</td>
<td>100.0%</td>
<td>100.0%</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure(1): ROC Curve for detection of NT-proBNP cutoff as regard cases

Table 8: Change assessment in follow up among cases as regard ECG, Echocardiography and tissue Doppler Echocardiography

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Atadmission(20cases)</th>
<th>After 6 weeks follow up(20cases)</th>
<th>Pairedt</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>QTC (X²±SD)</td>
<td>0.44±0.09</td>
<td>0.36±0.01</td>
<td>3.614</td>
<td>0.002*(S)</td>
</tr>
</tbody>
</table>
E(m/s) (X²±SD) 1.23±0.37 0.82±0.09 4.927 0.00** (HS)
A(m/s) (X²±SD) 0.51±0.1 0.51±0.07 .122 0.904 (NS)
E/A (ratio) Median(range) 2.35 (1.3-5.6) 1.58 (1.03-2) 3.734 0.001** (HS)

IV. DISCUSSION

Acute post-streptococcal glomerulonephritis (APSGN) can result from impetigo or pharyngitis caused by group A streptococci. APSGN is an immune complex-mediated disorder. Nephritogenic immune complexes are formed in the circulation, which are deposited in the glomeruli as they move through this structure. Antigens and antibodies meet in or outside the glomerular basement membrane, which causes an in situ immune complex disease. Chemical mediators and cytokines along with immune cell recruitment and local activation of the complement and coagulation cascade drive a glomerular inflammatory response. APSGN is demonstrated by the sudden onset of hematuria, edema, hypertension, and reduced renal functioning (15).

Cardiac complications in children with APSGN can be the presenting feature and may develop during the disease course. Renal failure, electrolyte imbalance and hypertension are leading causes to fluid retention which is precipitating factor for congestive cardiac failure (CCF) that can occur in 15 to 50% children with APSGN leading to apparent morbidity and rarely death (3).

However, it was found that some patients with APSGN presented with cardiac failure despite having normal blood pressure and serum electrolyte. In these patients, it was suggested that primary myocardial dysfunction probably caused the cardiac failure. Despite the common association, there are very few studies describing the cardiac status of children with APSGN (3). Our study aimed to detect the cardiac changes during the acute stage of PSGN by QTc, conventional echocardiography, tissue Doppler imaging and NT-pro BNP plasma levels to correlate it with clinical findings and other investigations.

Macroscopic or microscopic hematuria, edema, and hypertension are the major clinical findings (2). Twenty children with APSGN presented with statistically significant high percentage (100%) of oedema, hypertension and hematuria while there were statistically significant low percentage of Oliguria (35%), encephalopathy (10%) and convulsions (15%). These results were in accordance with Idhate et al (3) who found that the majority of cases presented with hypertension, oedema and hematuria while five children (16.6%) with congestive cardiac failure (CCF), and two (6.6%) with hypertensive encephalopathy. Bai and Kumar (16) study showed that hypertension was present in 30 (60%) children. Manhas et al (17) showed that 69% of cases had hypertension.

Our study showed highly statistically significant increase in both systolic and diastolic blood pressure among cases of APSGN in comparison to control group. The mechanism causing hypertension in parenchymal renal disease reflects a continuum ranging from pure volume-mediated hypertension to pure vasoconstriction-mediated hypertension, and combinations of both are common. In acute glomerular disorders, the prevailing cause is an acute drop in GFR, leading to salt and water retention (18).
Our study showed that RBCs and protein in urine were significantly higher among cases than controls in accordance with Chehade et al (19) who found that urinalysis revealed nephrotic-range proteinuria and red blood cell casts with dysmorphic red blood cells. Similarly, Demircioglu et al (20) detected proteinuria in 77.3% of the patients. In the literature, 34-44% of proteinuria cases were in nephrotic range at APSGN onset persistence or massive proteinuria is seen in only 2-7% of patients with APSGN. A number of studies from different countries also reported that nephrotic range proteinuria is not associated with disease severity and/or renal failure (19).

In general, the normal QT interval is below 400 to 440 milliseconds (ms), or 0.4 to 0.44 seconds. Due to the effects of heart rate, the corrected QT interval (QTc) is frequently used. The QTc is considered prolonged if greater than 450 ms in males and 470 ms in females (21).

As regard to QTc interval our study showed that there was statistically significant increase of QTc interval > 0.44 in 9 (45%) of our cases among cases of APSGN in comparison to control group. Similarly, Singh et al (5) reported 19 patients out of 34 (55.9%) with prolonged QTc. El-Gamasy and El-Shehabi (22) found prolonged QTc interval in 22 (36.7%).

In our study, there is statistically significant increase in the LA, LA/Ao and non-significant difference of Ao dimensions in cases as compared to the control group, this result was supported by the findings of Almuntaser et al (23) who found significant increase in LA dimension in cases with early hypertension when compared to control group. Balat et al (24) results agreed with the above findings and further explained that the increased LA dimensions and volume could be a compensatory mechanism through accommodation for increased volume load. Similarly, Idhate et al (3), showed in his study, seven patients had evidence of increased LA/AO ratio, thereby suggesting left atrial enlargement due to hypervolemia.

We found that there was statistically significant increase in dimensions as regard MPA, RPA and LPA in cases with APSGN in comparison to control group, most probably due to left ventricular dysfunction resulting from volume over load and hypertension as explained by Raymond et al (25).

In our study we found that there was statistically significant increase LVEDd and non-significant increase of LVESd in cases as compared to control group. This result was in accordance with Jankauskiene et al (26) who found that in the acute phase, APSGN patients a premier LVEDd in comparison with the control group. Similarly, Tasksen et al (27) found that the LVEDd measurements were higher in the patient group than in control group. Cacciapuoti et al (28) found that LVEDd was within normal ranges in cases of APSGN and control group. Although this study does not agree with our results, yet they were conducted on adults, which might explain the different findings.

Our study showed that there was statistically significant decrease in PW with non-significant decrease in IVS in comparison between our cases and control. This was in disagreement with Kotb et al (29) who noted that the IVS and PW thickness change was not statistically significant differing.

Using conventional echocardiographic for estimation of diastolic functions, we reported that there was statistically significant increase in mitral peak flow velocity of early filling (E) in cases group in comparison to the control group. This result was in disagreement with Jankauskiene et al (26) who found statistically significant decrease in mitral peak flow velocity of early filling (E) in cases of APSGN in comparison to the control group.

Our study also showed that there was increase in the mitral peak velocity of late filling (A) with significant increase in E/A ratio in cases of APSGN in comparison to control group. Our results matched with Jankauskiene et al (26) who found statistically significant increase in mitral peak velocity flow of late filling and E/A ratio between cases of APSGN and control group. Idhate et al (3) found seven patients had reversal of the E/A ratio on echocardiography indicating the presence of diastolic dysfunction. El-Gamasy and El-Shehabi (22) detected 14 children had reversal of E/A ratio. However, Jankauskiene et al., (26) found no statistically significant difference in mitral peak flow velocity of late filling and E/A ratio between cases of APSGN and control group.

To explain the situation in cases of mixed increase in preload and afterload effects on conventional diastolic function is rather complex. It has been suggested that ventricular diastolic function is abnormal in patients with
renal failure (as an example of mixed increase in preload and afterload) based on peak inflow velocity measurements in the rapid early (E) filling phase of diastole and the later atrially mediated phase (A) (30). However, an increase in preload elevates the left atrial pressure which eventually increases the early part of the LV filling (E wave) and thus resulting in restoration of the E/A ratio back to normal or even to an increased value despite the presence of diastolic dysfunction, this changes in Doppler pattern is called pseudonormalization(31).

In the present study of diastolic tissue Doppler velocities, there was significant decrease in E/A' ratio in cases of APSGN as compared to controls, this result is in accordance with Almuntaser et al (23) who found significant decrease in E/A’ ratio in cases of APSGN in comparison to control group.

The ratio between early diastolic velocity of mitral inflow (E) and early diastolic mitral annulus velocity (E') known as (E/E') was described by some authors as the best noninvasive predictor of elevated LV filling pressure in the comparison between multiple echocardiographic indices and the final diastolic pressure measured by hemodynamic catheter, using lateral E' (32,33).

TDI in our study showed statistically significant difference between cases and control as regard the ratio between the early velocities by conventional echocardiography and the early velocities by TDI (E/E') on the mitral annulus. The significantly elevated E/E' ratio in our study could be due to a combination of preload (volume) and afterload (hypertension) increase with the rise in LV filling pressure. Firstenberg et al (34) in his study similarly concluded that E/E' was a relatively preload dependant in a group of subjects with normal LV function. This result was in accordance with Almuntaser et al (23) and Qureshi et al (35) who found statistically significant increase in E/E' on comparison between early hypertensive cases and controls.

In our study the plasma levels of NT-pro BNP showed a statistically high significant increase in comparison to control in accordance with Taskesen et al (27) who found that plasma NT-proBNP levels are higher in the patient group than in the control group and related to the severity of symptoms. High levels of NT-pro BNP in patients may be due to volume overload caused by APSGN, which is not related to primary cardiac dysfunction.

In accordance with Kotaska et al (36) the differences between systolic function measured by conventional echocardiography and tissue doppler between our patients with APSGN and controls were not statistically significant, the NT-proBNP levels of patients were significantly higher than controls upon admission and had significant positive correlation with EF and FS. Also, NTpro BNP had significant positive correlation with E and E/A ratio. As well as there was a statistically significant positive correlation between NT-proBNP and E'/E' ratio in cases of APSGN during the acute stage, while there is statistically significant negative correlation between NT-proBNP and A', E' in cases of APSGN during the acute stage denoting that diastolic dysfunction was related to elevated level of NT-pro BNP. It may be speculated that the association of high plasma NT-proBNP levels and adverse outcomes could be simply a reflection of elevated filling pressures due to diastolic dysfunction (37).

Levels of BNP in our study showed a significant positive correlation with LA, LA/AO and LVESD dimensions and significant negative correlation with IVS. Puddy et al (12) and Nir et al (14) found that higher natriuretic peptide levels have been reported in the conditions with marked atrial distension and left ventricular overload. Similarly, Shor et al., (38) found that only two associations were noted between BNP values and echocardiographic parameters, one was a positive association with E/A ratio, the other was a negative association with EF.

ROC curve analysis revealed an area under curve with cutoff >55.3(pg/ml). The sensitivity was 90%, specificity was 70% and 80% accuracy. This was in accordance with Mueller et al (39). However, Taskesen et al (27) found that ROC curve was difficult to evaluate a cut off level for NT-pro BNP levels, which may be indicative and used as an indicator of specific cardiac and/or volume disturbance.

In our study after six weeks follow up, we observed that there was a significant decrease in plasma NT-proBNP levels in accordance with Taskesen et al (27) Who found that a significant reduction in the NT-pro BNP levels in the APSGN group especially after diuretic therapy initiation. So, the measurement of NT-proBNP is useful and relevant in the follow up of various types of cardiovascular diseases as regarded by Kotaska et al (36).

There was significant decrease as regard QTc, E, E/A ratio, LA, LA/AO ratio in cases of APSGN. While, there were significant increase as regard IVS, LVEDd and A' in cases after six weeks follow up in comparison to the results during the acute stage. Also, there were no statistically difference as regard A, AO, PW, LVESd, EF%,
Cases with acute post streptococcal glomerulonephritis showed left ventricular dilatation and hypertrophy (Increase in the left ventricular end-diastolic diameter and wall thickness). Prolonged QTc interval reveals a myocardial affection. NT-proBNP is a helpful biomarker in diagnosis of cardiac affection in cases with APSGN and had statistically significant positive correlation between NT-proBNP and SBP, DBP, Platelets, Creatinine, Potassium, ASOT, QTc, E/E' ratio, MPA, RPA, LPA, PW, LVEDd, EF% and FS%. The abnormalities in laboratory findings including NT-proBNP, ECG and Echocardiography data are transient as they return to normal by six weeks duration of follow up.

V. CONCLUSION

Cases with acute post streptococcal glomerulonephritis showed left ventricular dilatation and hypertrophy (Increase in the left ventricular end-diastolic diameter and wall thickness). Prolonged QTc interval reveals a myocardial affection. NT-proBNP is a helpful biomarker in diagnosis of cardiac affection in cases with APSGN and had statistically significant positive correlation between NT-proBNP and SBP, DBP, Platelets, Creatinine, Potassium, ASOT, QTc, E/E' ratio, MPA, RPA, LPA, PW, LVEDd, EF% and FS%. The abnormalities in laboratory findings including NT-proBNP, ECG and Echocardiography data are transient as they return to normal by six weeks duration of follow up.

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