ORIGINAL ARTICLE

Assessment of Right Ventricular Function in Patients with Acute Myocardial Infarction by Tissue Doppler

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**Background**
Right ventricular infarction is a potentially reversible cause of cardiogenic shock so that, accurate diagnosis and therapy have been advocated. Myocardial and annular velocities determined by Doppler tissue imaging (DTI) is a simple technique that has been used to analyze left ventricular function, and opens up also the possibility of assessing right ventricular function.

**Objective**
To assess the right ventricular function by using of tricuspid annular motion and tricuspid annular velocity determined by DTI in patients with AMI.

**Methods**
Fifty patients were included in this study, and diagnosed as AMI, 24 of them with inferior infarction (group I) which subdivided into I(A) (with RV infarction) and I(B) (without RV infarction), while other 26 patients with anterior infarction (group II). Ten healthy volunteers (group III) were included with matched age and sex. All patients were subjected for full history taking, clinical examination, ECG, echocardiography to determine tricuspid annular plane systolic excursion (TAPSE), LVEF, and RVEF, RV wall motion abnormalities, and presence of tricuspid regurgle. DTI was done to detect tricuspid systolic (Sa) and diastolic (Ea, Aa) velocities.

**Results**
There was significant reduction in TAPSE in both group I and group II as compared to group III (p <0.01, p <0.05 respectively), and it was more in group I(A) compared to group I(B), (p <0.01). The mean value of Sa velocity in group I was reduced compared with both group II and group III, (p <0.05 of both), also it was highly significant reduced in group I A as compared to group I B, (p <0.01). There was positive correlation between TAPSE and both RVEF in group I (p< .001) and LVEF in group II (p <0.05).

**Conclusions**
TAPSE by M-mode echocardiography and TAV by DTI can be used for RV function assessment in patients with AMI.

**Keywords**
RV function assessment, Tissue Doppler, Echocardiography TAPSE.

INTRODUCTION
Ischemic right ventricular (RV) dysfunction is common in patients with acute transmural infero-posterior left ventricular myocardial infarction (MI) and often results in depressed global RV performance and hemodynamic compromise characterized by predominant right heart failure and low cardiac output (1).

Right ventricular infarction is a potentially reversible cause of cardiogenic shock, so that accurate diagnosis and therapy have been advocated (2).

A hypokinetic or akinetic segment of the RV observed by echocardiography also could be used to detect RV dysfunction after RV infarction. However, because of the complex shape, evaluation of RV function by echocardiography has been considered difficult (3).

Previous studies have used tricuspid annular motion to assess RV function (4). Myocardial and annular velocities determined by Doppler tissue imaging (DTI) is a technique that has been used to analyze left ventricular (LV) function. The development of DTI opens up the possibility of also assessing RV function. However, this technique has not been used to assess RV function after MI (5).

The purpose of the current work was to study RV function in association with an acute first myocardial infarction.

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Abbreviations and Acronyms

- AMI: Acute Myocardial Infarction
- Ea and Aa: Early and late diastolic tricuspid annular velocities
- PHT: Pulmonary Hypertension
- PW-DTI: Pulsed Wave Doppler Tissue Imaging
- RVEDd: Right Ventricular End Diastolic Dimension
- RVEF: Right Ventricular Ejection Fraction
- RV-FW: Right Ventricular Free Wall
- Sa: Systolic tricuspid Annular velocity
- TAPSE: Tricuspid Annular Plane Systolic Excursion
- TAV: Tricuspid Annular Velocity
- TR: Tricuspid Regurgitation
- TVI: Time Velocity Integral

METHODS

The present study included fifty patients admitted at CCU of Benha University Hospital, and presented with first time by acute myocardial infarction during the period between January 2010 to March 2011, and were divided according to (ECG) criteria into two main groups:

**Group I:** Included (24) patients with recent inferior MI, which was subdivided into:
- **Group I(A):** Included (10) patients with right ventricular infarction.
- **Group I(B):** Included (14) patients without right ventricular infarction.

**Group II:** Included (26) patients with recent anterior myocardial infarction.

Ten apparently healthy volunteers were included in this study with matched age and sex as a control group (Group III).

Exclusion Criteria:

- Patients with previous MI, AF, COPD, and patients with tricuspid valve disease.

All Patients Were Subjected to the Following:

1. **Careful history taking:** with special emphasis on risk factors of ischemic heart disease as DM, HTN, obesity, smoking, dyslipedamia, and positive family history of CAD.
2. Thorough clinical examination.
3. **Resting electrocardiogram:** 12 leads surface resting electrocardiogram including right chest leads (V2R and V3R) to detect right ventricular infarction.
4. **Measurement of cardiac enzymes:** CK–MB and Cardiac troponin I were estimated to diagnosis of AMI (6).

The serum level more than 0.5ng/ml and 40ng/ml, respectively is diagnostic for AMI (7).

5. **Standard echocardiography:** M-mode, 2D and Doppler echocardiography data were obtained in all patients and healthy individuals within the first week of admission in supine and left lateral positions. The equipment used was a Hewlett-Packard Sonos 5500 phased-array systems equipped with Doppler tissue imaging (DTI) technology, using variable-frequency, phased array transducer (2.0 to 4.0 MHZ). Measurements were performed according to the recommendations of the American society of echocardiography (8).

**M-Mode Echocardiography:**

By using short and long axis parasternal views with the transducer position at the 3rd left intercostal space to measure the following:

- Left ventricular end-diastolic dimension [LVEDd].
- Right ventricular end-diastolic dimension [RVEDd].
- Tricuspid annular plane systolic excursion (TAPSE): tricuspid annular plane systolic excursion was recorded at RV free wall from the apical 4-chamber view, in the real-time 2-D apical 4-chamber view, the M-mode cursor was placed through the tricuspid annulus in such a way that the annulus moved along the M-Mode cursor. The displacement of the tricuspid annulus was recorded in M-mode.

**Two-Dimensional Echocardiography: Was Used to Assess:**

- **Left ventricular ejection fraction (LVEF%) and RV Ejection fraction (RVEF%):** were calculated as the percentage of changes in LV and RV volumes between diastole and systole in both apical 4-and 2-chamber views using modified Simpson's rule (8, 9). (Area length method): End-diastolic area-End-systolic area X 100 End- diastolic area
- **Right ventricular wall motion abnormalities (RVWMA):** from apical 4-chamber, long and short axis parasternal views, segmental wall motion abnormalities of the RV (hypokinesia, akinesia and dyskinesia) at the apical, mid-zonal, and the basal portions of the RV free wall as well as the presence or absence of paradoxical septal motion (PSM) were assessed.

**Doppler Echocardiography:**

1. **Doppler trans-tricuspid flow velocities:** by placing the sample volume between the leaflets tips in the center of the flow stream. The following measurements were taken:
   - Peak early diastolic velocity (E) in cm/s.
   - Peak atrial diastolic velocity (A) in cm/s.
2. **Assessment of tricuspid regurgitation:** The presence of tricuspid regurgitation was assessed qualitatively by color flow (size of the jet), PW- and continuous Doppler.

**Pulsed-Wave Doppler Tissue Imaging (DTI):**
From the apical 4-chamber view, the DTI cursor was placed at the tricuspid annulus at the place of attachment of the anterior leaflet of the tricuspid valve with RV-FW in such a way that the annulus moved along the sample volume line. Care was taken to obtain an ultrasound beam parallel to the direction of the tricuspid annular motion. Doppler velocity range from -30 to +30 cm/s was selected, and velocities were measured:

1. **Peak systolic (Sa) velocity in (cm/s):** recorded when the tricuspid ring moved towards the cardiac apex. (S= Systolic; a= annulus).

2. **Peak early diastolic (Ea) wave:** were corresponding to the early filling phase.

3. **Peak late diastolic (Aa) wave:** were corresponding to atrial systole.

4. **Ea/Aa ratio** was calculated.

**Statistical Analysis**
Data were collected from total patients (group I and II) and healthy individuals (group III) and expressed as the mean value, standard deviation and percentages. Kruskal – Wallis test was used to compare different parameters between groups. When inter-group differences were found, Mann- Whitney test was performed to determine which groups were significantly different.

Categorical variables were analyzed with the Chi square test. Paired student’s t-test was used to compare measures of tricuspid annular plane systolic excursion and tricuspid annular velocity at RV free wall of studied groups.

A value of P <0.05 was considered statistically significant (10).

**RESULTS**
The present study was carried out on (50) patients with AMI, and (10) apparent healthy volunteers, which divided into three groups:

- **Group I:** Included (24) patients with first time of Q-wave inferior myocardial infarction, they were 14(58.3%) males and 10(41.7%) females with a mean age of 51.7 years ±9.8.

- **Group II:** Included (26) patients with first time Q-wave anterior MI; 16(61.5%) males and 10(38.5%) females with a mean age of 51.0 years ±11.1.

- **Group III:** Included (10) healthy individuals, 7(70%) males and 3(30%) females with a mean age of 48 years ±10.7.

Out of 24 patients with inferior wall MI (group I), 10 patients (41.7%) had ECG evidence of right ventricular involvement (i.e. elevated ST-segment in V4R).

There was no significant difference in the prevalence of smoking, hypertension, dyslipidemia and positive family history for coronary artery disease (CAD) of the studied groups.

**Echocardiography:**

**A) M-Mode and 2-Dimensional Echocardiography Data (Tables 1)**

1. **Right ventricular end diastolic dimension (RVEDd):** There was a significant increase in the mean value of RVEDd in group I, it was (24.6±5.02mm) as compared to group II (21.9±3.9mm)(p <0.05) and group III (19.4±2.6mm), (P <0.01). The increase in RVEDd was more pronounced in group I(A) compared with group I(B), (P <0.001).

2. **Left ventricular end diastolic dimension (LVEDd):** There was a significant increase in mean value of group II as compared to group I (p <0.05) and III, (P <0.01).

3. **RVEDd/LVEDd ratio:** There was a significant increase in group I, it was (0.51±0.13) as compared to group II (0.41±0.05) and group III (0.43±0.04), (P <0.05 of both).

   There was a significant increase in the ratio of group I(A) (0.67±0.09) as compared to group I(B) (0.44±0.05, P <0.01).

4. **Right ventricular wall motion abnormalities (RVWMA):** 12(50%) patients in group I, 8(80%) patients in group, I(A) and 4(28.5%) patients in group I(B) had RVWMA. The RVWMA was more significantly pronounced in group I(A) as compared to other groups, (P <0.001), while no wall motion abnormalities was found on other groups.

5. **Left ventricular ejection fraction (LVEF%):** There was a significant reduction in group II compared with group III (P <0.01).

6. **Right ventricular ejection fraction (RVEF%):** There was a significant reduction in group I (40.1%±10.5) compared with both group II (45.6%±7) (p <0.05) and group III (56.0%±4.9), (P <0.01). The reduction was more pronounced in group I(A) (26.50%±7.01) compared with group I(B) (44.47%±2.74), (P <0.001).
B) Conventional Doppler Echocardiography

1- Tricuspid Regurgitation (TR):
Seven of patients (70%) in group I A had TR (grade >2+), 4 patients (28.5%) in group I B, and only one patient (3.8%) in group II had grade I TR.

2- Pulsed Wave Doppler Trans-Tricuspid Flow:
• **Peak E wave**: There was a significant reduction in the mean value of peak early diastolic filling wave (E) in group I, it was (47±9cm/s) as compared to group II (53±9cm/s) and group III (56±9cm/s), (P <0.05) of both, also there was a significant reduction in group I(A) 41±1cm/s compared with group I(B) (49±8, p <0.05).
• **Peak A wave**: There was no difference in the late diastolic filling wave of studied groups.

• **E/A ratio**: There was a significant reduction in the ratio of group I, it was (1.04±0.22) as compared to group III (1.23±0.12), (p <0.05), also in group I(A) (0.90±0.30) as compared to group I(B) (1.11±0.14), (p <0.05), but there were insignificant differences in group I versus group II and group II versus group III, (P >0.05).

C- Tricuspid Annular Velocity of TDI at RV Free Wall (Table 2)

- **Peak early systolic velocity (Sa cm/s)**: There was a significant reduction in the mean value of Sa velocity of group I, it was (13±2.5cm/s) as compared to group II (15.1±1.5cm/s) and group III (15.6±1.1cm/s), (p <0.05) of both, but it was insignificant difference between group II and III (P >0.05).

Table 1: Echocardiography data of the studied groups:

<table>
<thead>
<tr>
<th></th>
<th>Group I n= 24</th>
<th>Group I(A) n= 10</th>
<th>Group I(B) n= 14</th>
<th>Group II n= 26</th>
<th>Group III n= 10</th>
<th>P value</th>
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<tbody>
<tr>
<td>RVEDd (mm)</td>
<td>24.6±5.02</td>
<td>30.2±2.2</td>
<td>21.94±3.5</td>
<td>21.9±3.9</td>
<td>19.40±2.6</td>
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<td>LVEDd (mm)</td>
<td>48.5±5.2</td>
<td>45.63±4.6</td>
<td>49.8±5</td>
<td>53.7±5.5</td>
<td>45.4±4.1</td>
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<td>LV EF %</td>
<td>55.8±5.3</td>
<td>54.13±5.6</td>
<td>56.5±5.03</td>
<td>49.6±6.2</td>
<td>66.9±4.2</td>
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<tr>
<td>RV EF %</td>
<td>40.1±10.5</td>
<td>26.50±7</td>
<td>46.47±2.7</td>
<td>45.6±7</td>
<td>56±4.9</td>
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<tr>
<td>RVWMA</td>
<td>12(50%)</td>
<td>8(80%)</td>
<td>4(28.5%)</td>
<td>0(0.00%)</td>
<td>0(0%)</td>
<td>*&lt;0.001</td>
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<td>Patient with TR</td>
<td>12(50%)</td>
<td>7(70%)</td>
<td>4(28.5%)</td>
<td>1(3.8%)</td>
<td>0(0%)</td>
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</table>

* P compared I with group III.
** P compared group II with group III.
# P compared group I with group II.
^ P compared group IA with group IB.
RVEDd = Right Ventricular End Diastolic dimension, LVEDd = Left Ventricular End Diastolic dimension, RVWMA = Right Ventricular Wall Motion Abnormalities, TR = Tricuspid Regurgitation, LVEF= LV Ejection Fraction, RVEF= RV Ejection Fraction.
• **Peak early diastolic velocity (Ea cm/s):**
  It was significantly reduced in group I (11.7±3.0cm/s) as compared to group II (14.1±1.8cm/s) and group III (14.9±1.7cm/s), (p <0.05) of both, while it was insignificant reduction in group II, when compared with group III (healthy individuals), (P >0.05).

• **Peak late diastolic velocity (Aa cm/s):**
  It was significantly increased in group I (16.9±2.9cm/s) compared with group III (14±1.6cm/s), (p <0.05), and also between group I (A) and group I B (p <0.01).

• **Ea/Aa ratio:**
  It was a significantly reduced in group I (0.69±0.11) as compared to group II (0.92±0.19) (p <0.05) and group III (1.07±0.16), (P <0.01). There was a significant reduction in group II compared with group III, (p <0.05). The reduction was more pronounced in group I(A) (0.57±0.07) compared with group I(B) (0.74±0.09) (P <0.01).

**D- Tricuspid Annular Plane Systolic Excursion (TAPSE) (Table 2)**

There was a significant reduction in TAPSE in group I, it was (19.1±2.8mm) as compared to group II (22.4±2.2mm) and group III (25±1.6mm), (p <0.05), (p <0.01) respectively, also there was a significant reduction in group II compared with group III, (p <0.05). The reduction was more pronounced in group I(A) (15.8±1.4mm) compared with group I(B) (20.68±1.6mm), (p <0.01).

There was positive correlation between TAPSE and RVEF in patients with group I (p <0.001), and also between TAPSE and LVEF with group II (p <0.05) (Figure 1, 2).

**Table 2:** Comparison of tricuspid annular plane systolic excursion (TAPSE) and tricuspid annular velocity (TAV) of the studied groups:

<table>
<thead>
<tr>
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<th>Group I n= 24</th>
<th>Group I(A) n= 10</th>
<th>Group I(B) n= 14</th>
<th>Group II n= 26</th>
<th>Group III n= 10</th>
<th>P value</th>
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<tbody>
<tr>
<td>TAPSE (mm)</td>
<td>19.1±2.8</td>
<td>15.8±1.4</td>
<td>20.6±1.6</td>
<td>22.4±2.2</td>
<td>25±1.6</td>
<td>*&lt;0.01</td>
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<tr>
<td>Sa wave</td>
<td>13±2.5</td>
<td>10±1.1</td>
<td>14.4±1.4</td>
<td>15.1±1.5</td>
<td>15.6±1.1</td>
<td>**&gt;0.05</td>
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<tr>
<td>Ea wave</td>
<td>11.7±3</td>
<td>7.8±0.66</td>
<td>13.5±1.4</td>
<td>14.1±1.8</td>
<td>14.9±1.7</td>
<td>**&lt;0.05</td>
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<tr>
<td>Aa wave</td>
<td>16.9±2.9</td>
<td>13.7±1.15</td>
<td>18.5±2.25</td>
<td>15.6±1.9</td>
<td>14.1±1.6</td>
<td>**&gt;0.05</td>
</tr>
<tr>
<td>Ea/Aa ratio</td>
<td>0.69±0.1</td>
<td>0.57±0.07</td>
<td>0.74±0.09</td>
<td>0.92±0.19</td>
<td>1.07±0.16</td>
<td>*&lt;0.01</td>
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</tbody>
</table>

* P Compared group I and group III.
** P compared group II with group III.
# P compared group I with group II.
^ P compared group IA with group IB.
Sa = Systolic TAV, Ea and Aa = Early and late diastolic TAV.
Figure 1: Comparison between RVEF and TAPSE in group I (P value <0.001).

Figure 2: Comparison between LVEF and TAPSE in group II (P value <0.05).

DISCUSSION
TAPSE has been proposed as a simple and reproducible parameter for quantitative assessment of RV ejection fraction (8). The prognostic importance of TAPSE in the evaluation of RV function in patients with severe heart failure has been well-described (11), and the parameter has been recommended in the most recent joint American European guidelines for echocardiography quantification of right ventricular function (12). Later studies showed the prognostic information in a mixed heart failure patients as well (13).

More validation studies have confirmed the relation between RV ejection fraction and TAPSE in various heart failure populations, although the association is modest in patients with preserved RV function (14, 15). In addition, it has been suggested that TAPSE may not be entirely independent of LV function (16). Reduced LVEF seem to have an impact on TAPSE, even in the setting of preserved RVEF (17).

In the present study, tricuspid annular plane systolic excursion determined by 2-D guided M-mode echocardiography and tricuspid annular velocity determined by PW-DTI was used as an index for assessment of RV function.

However depending upon the electrocardiography criteria used for diagnosis, it was found that RV involvement was exclusively a complication of inferior wall myocardial infarction with a frequency of 41.7% (10 of 24 patients) and of 20% overall incidence in patients with acute myocardial infarction.

This incidence was similar to Lew et al. (1985) who reported that; presence of RV involvement in 42% of patients with inferior MI (18).

This study was found that, patients with inferior MI who had RV involvement (group IА) had significantly increased RVEDd and RV/LV end-diastolic dimensions ratio compared with patients without RV involvement (group IB) (RVEDd, 30.2±2.2 vs. 21.94±3.9mm (p <0.001) and RVEDd/LVEDd ratio, 0.67±0.9vs. 0.44±0.05, P <0.01).

This is in agreement with Panidis et al. (1983); who found that, the mean RVEDd and RVEDd/LVEDd ratio were significantly higher in patients with inferior MI and RV involvement (28.2±4.0mm vs. 18.23±3.9mm, P <0.01 respectively) (8).

We found that (80%) of patients with RV involvement [group IА] had RVWMA in the form of paradoxical septal motion and hypokinesia, akinesia or dyskinesia of RV-FW, compared with (28.5%) of patients in group I(B).

These results was came in agreement with that reported by Panidis et al. (1983); who observed the presence of RVWMA in about 71.4% of patients with RV involvement (8). In the other hand, Alam et al. (2000) (19); reported that RVWMA were seen only in about 55% of patients with RV infarction and none of the patients without ECG signs of RV involvement had RVWMA.

This discrepancy may be explained by important factors, first inter and intra-observer variability, and second some wall motion abnormalities can be transient, even in the presence of infarction of some islands of normal tissue are preserved (19).

The estimated RV EF was significantly lower in patients with anterior MI , it was (45.6±7) as compared to healthy individuals (group III) it was (56%±4.9) (P <0.05). This may be explained by the fact that motion of inter-ventricular septum, which is part of the RV, is commonly impaired in patients with anterior wall MI. On the other hand, patients with RV involvement [group IА], RVEF was significantly lower compared with group I(B), (26.50%±7vs. 46.47%±2.7, P <0.001).

These results in agreement with that reported by Starling et al. (1982) ; who observed a significantly lower RVEF in patients with hemodynamically documented RV involvement than in patients without, both by first pass (28% vs. 41%) and gated equilibrium (28% vs. 44%) techniques (20).

The estimated significant tricuspid regurgitation (grade >2+) was found in (70%) of patients with RV involvement [group IА] versus (28.5%) in group I(B) and in group II was (3.8%). The results also are comparable to that reported by Alam et al. (2000); who found that, about
(33%) of patients with RV involvement had significant TR (grade >2+) (19).

We found that, patients with RV involvement had significant lower peak early filling "E" wave as well as E/A ratio compared with other groups. In patients with RV involvement E/A ratio usually less than 1.0 and this means that patients had impaired RV diastolic function. On the other hand, patients without RV involvement had E/A ratio more than 1.0, and this in agreement with that reported by Joseph and Jose (1990); who found that all patients with ECG signs of RV infarction or clinical evidence of RV failure had E/A ratio <1.0 (21).

In the present study, there was significantly reduced mean value of TAPSE of both group I and group II compared with group III, (p <0.01, p <0.05 respectively). In group I (inferior MI) the reduction was highly significant in patients with RV involvement [group I(A), 15.8±1.4] compared with those without RV involvement [group I(B), 20.6±1.7, p <0.01], also we found that a positive correlation between TAPSE and RV ejection fraction (RV EF) in group I (p <0.001), and TAPSE as compared to LVEF in group II (p <0.05) (Figure 1, 2).

Therefore from the present study, there was evidence that TAPSE was greatly affected in patients with inferior MI especially those with RV involvement and this means that RV systolic function was greatly depressed in patients with inferior myocardial infarction associated with RV involvement compared with other groups.

Alam et al. (2000); by using echocardiography for assessment of TAM at RV free wall and septal sites of the annulus in patients with recent MI, but data about motion at septal site not mentioned. The results of this study revealed that, systolic TAM was significantly lower in patients with inferior MI (20.5±5mm) as well as anterior MI (23±4mm) compared with healthy individuals (27±4mm, p <0.001) respectively; the TAM was significantly lower in patients with RV infarction (p <0.001), and this was in agreement with the finding in our study (19).

Kaul et al. (1984); demonstrated that the systolic shortening of the RV from apex to base referred to tricuspid annular plane systolic excursion (TAPSE) is an echocardiography index that correlates with radionuclide RV ejection fraction, they recorded that, TAPSE in normal population was consistently greater than 15mm, They concluded that, the advantages of the proposed method in which TAPSE is used to estimate RV EF include simplicity, reproducibility, and absence of geometric assumptions or traceable endocardial outlines (22).

Doppler Tissue Imaging Parameters:

The right ventricular systolic function (Sa) was greatly reduced in patients with inferior MI specially those associated with RV involvement and this means that RV systolic function was greatly depressed in patient with inferior MI associated with RV involvement compared with other groups.

The right ventricular diastolic function, estimated by trans-tricuspid flow velocity profiles by conventional Doppler only reflect the global diastolic function and are preload-dependent. The mean value of diastolic parameters determined by DTI represents the global function. By using the diastolic DTI parameters individually at different sites, the regional diastolic function can be readily assessed (23).

On estimation of Ea/Aa ratio, it was significantly reduced in group I compared with both group II and group III (p <0.05), (P <0.01) respectively. The reduction was highly significant in group I(A) compared with group I(B) (P <0.01).

Alam et al. (2000); also used PW-DTI for assessment of TAV at right ventricular free wall and septal sites of the annulus in patients with first MI as an index of RV systolic and diastolic functions. The results of this study revealed that, the peak systolic tricuspid annular velocity determined by DTI was significantly reduced in patients with inferior MI compared with both healthy individuals and patients with anterior MI, p <0.001 respectively. In addition to a decreased peak systolic velocity, the peak early diastolic velocity was also reduced in patients with inferior MI compared with healthy individuals and patients with anterior MI (P <0.001 respectively). In addition peak systolic and early diastolic velocities were significantly decreased in patients with electrocardiographic signs of RV infarction compared with those without RV infarction, (P <0.001), and these were in agreement and comparable with the present study (19).

Kjaergaard et al. (2009); used TAPSE as parameter for right ventricular function assessment in patients with heart failure, they examined 634 patients admitted for symptomatic heart failure, and found that TAPSE were correlated with global and regional measures of diastolic LV function as measured from transthoracic echocardiography, also LVEF, wall motion index scores, atrio-ventricular annular plane systolic excision of mitral annulus were significantly related to TAPSE (p <0.01, <0.05, and <0.001 respectively) (24).

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