Comparison of the assessment of left ventricular ejection fraction by Teichholz and Simpson’s method

Deepa Lakshmi¹, Vigneswari Sekar², Ram Murugesan³, Dr. Durga Devi⁴, G. Ashok⁵*, M. Chokkalingam⁶

¹Cardiac Technology, Faculty of Allied Health Sciences, Chettinad Hospital and Research Institute (CHRI), Chettinad Academy of Research and Education (CARE), Kelambakkam, Tamil Nadu, India

²Clinical instructor, Faculty of Allied Health Sciences, Chettinad Hospital and Research Institute (CHRI), Chettinad Academy of Research and Education (CARE), Kelambakkam, Tamil Nadu, India

³Professor and Research Director, Chettinad Academy of Research and Education (CARE), Kelambakkam, Tamil Nadu, India

⁴Assistant Professor, Department of Cardiology, Chettinad Hospital and Research Institute (CHRI), Chettinad Academy of Research and Education (CARE), Kelambakkam, Tamil Nadu, India

⁵Assistant Professor and Consultant Interventional Cardiologist, Department of Cardiology, Chettinad Hospital and Research Institute (CHRI), Chettinad Academy of Research and Education (CARE), Kelambakkam, Tamil Nadu, India

⁶Professor and HOD, Department of Cardiology, Chettinad Hospital and Research Institute (CHRI), Chettinad Academy of Research and Education (CARE), Kelambakkam, Tamil Nadu, India

*Corresponding author:
Dr. G. Ashok
Assistant Professor and Consultant Interventional Cardiologist,
Department of Cardiology,
Chettinad Hospital and Research Institute (CHRI),
Chettinad Academy of Research and Education (CARE),
Kelambakkam, Tamil Nadu, India.

Abstract

Introduction: Left ventricular ejection fraction (LVEF) has been used for many years to assess left ventricular systolic function. Over time, patients may have LVEF measurements performed with the use of different imaging modalities. Ejection fraction measurements obtained with both the Teichholz and Simpson’s methods are directly comparable for evaluation of ejection fraction. This study is done to compare Teichholz method to Simpson’s method in patients with global hypokinesia of left ventricle. Methods: Prospective cross sectional study was done in 150 patients who underwent echocardiography at Chettinad Super Speciality hospital. Using conventional 2D echocardiography and Doppler Echocardiography left ventricular ejection fraction was assessed in various views (Apical four chamber, Apical two chambers and parasternal long axis) using VIVID S5 and Esaote. From the total subjects, 105 patients were male and 45 were females. In this study, we compare Teichholz method to Simpson’s method in patients with global hypokinesia of left ventricle. Results: Out 150

http://doi.org/10.36295/ASRO.2020.232215
patients 105 were male (70%) and 45 were female (30%). 38% (57) patients falls under the age group of 60-69 and 25% (38) falls under the age group of 50-59. 58% (86) of patients in Teichholz method and 55% (82) of patients in Simpson’s method had moderate left ventricular dysfunction. The mean value calculated by the Simpson’s method did not differ significantly from the mean value calculated by the Teichholz method. Contingency table for chi square test showed p<0.001 is significant. **Conclusion:** It has been noted that Teichholz method is non inferior in patients with global hypokinesia of left ventricle.

**Key words:** Ejection fraction; Global hypokinesia; Echocardiography; Teichholz and Simpson’s method.


**Introduction:** The left ventricle of the heart is the chamber that pumps blood to the rest of the body. Ejection fraction is the percentage of blood leaving from heart for each contraction. Ejection fraction is usually measures only in Left Ventricle. Common test to assess Left Ventricular Ejection Fraction is the echocardiogram. Left ventricular function is a important parameter in echocardiography. Left ventricular ejection fraction is assessed by many different ways like eyeballing, Teichholz and Simpson’s method. 2D Echo, M-Mode Echo, Doppler and 3D echo are used to assess Left ventricular function in both during systole and diastole. Teichholz method is based on single linear measurement of left ventricular cavity using M-Mode echocardiography. It is the first and most commonly used method to assess left ventricular function using Interventricular septum, leaflet ventricular posterior wall thickness and left ventricular internal diameter. Measurements of Left ventricle dimensions are used to calculate left ventricular ejection fraction in Teichholz method. This method of assessment of left ventricular ejection fraction is performed by all modern modalities. Simpson’s method is used to determine left ventricular ejection fraction. In Simpson’s method, Left ventricular ejection fraction is calculated by using both End Diastolic volume as well as End Systolic volume. This method involves manual tracing of Left ventricular cavity endocardium at end systole and end diastole in apical four chamber and apical two chamber view. Modern machines have an option to measure left ventricular ejection fraction using Simpson’s method. The apical four chamber view is the starting point in measuring left ventricular ejection fraction by Simpson’s method. In apical four chambers view left ventricular cavity is traced in End diastole and then end systole following which the left ventricular cavity is traced at End diastole and end systole in two chamber view. Left ventricular Ejection fraction is assessed by measuring the difference between End Diastole and End Systole value divided by the End diastole value. In Teichholz method left ventricular internal diameter in systole and diastole was measured in M-Echcardiography of parasternal long axis view at chordal level. In Simpson’s method recording an apical four chambers and apical two chamber view and Zooming on to left ventricle, endocardial border is outlined in end diastole and end systole to obtain end diastolic volume and end systolic volume. Left ventricular cavity is divided into disks and surface area of each disk is calculated and summed. In this study, we compare the assessment of Left Ventricular Ejection Fraction by Teichholz method and Simpson’s method in participant undergoing Echocardiography in Tertiary care Hospital in Tamil Nadu. Analysis of echocardiographic parameter relevant to teichhloz and Simpson’s method shows no significant changes in LVEF. Overall, our
results show the Simpson’s method did not differ significantly from the mean value calculated by the Teichholz method.

**Materials and Methods:** The study was conducted at Department of Cardiology Chettinad Hospital and Research Institute, Tamil Nadu, India. The participants were selected following the inclusion and exclusion criteria. The inclusion criteria (a) Patient undergoing Echocardiography, (b) Patients with global regional wall motion abnormality. Similarly, the exclusion criteria include (a) Patient with Aortic stenosis, Mitral stenosis, Aortic Regurgitation, Mitral Regurgitation (b) Patient under the age of 18. The informed consent was obtained from 150 individuals. The Participants were subjected to echocardiographic investigation, to calculate LVEF using Teichholz and Simpson’s method.

**Echocardiographic investigation:** Echocardiographic evaluation of 150 individuals at ChettinadSuperspecialty Hospitals with patients in left lateral decubitus and supine position using Vivid S5 and Esaote machines and a 3MegaHertz transducer. All patients with global regional wall motion abnormality have undergone echocardiographic evaluation (2D and colour Doppler imaging). The parameters used in this study to assess left ventricular ejection fraction are (A) Teichholz method, and (B) Simpson’s method.

**Teichholz method:** In M-mode echocardiography of parasternal long axis view left ventricular internal dimensions are measured

\[
LVEF = \frac{EDV - ESV}{EDV} \times 100
\]

LVEF- Left ventricular ejection fraction; EDV- End diastolic volume; ESV- End systolic volume

**Simpson’s method:** In apical 4 chambers and 2 chamber view, endocardial border is outlined in end diastole and end systole to obtain end diastolic volume and end systolic volume.

\[
LVEF = \frac{EDVol - ESVol}{EDVol} \times 100
\]

LVEF- Left ventricular ejection fraction EDVol- End diastolic volume

Statistical analysis: The statistical analysis was done using SPSS for windows version 21 software by IBM Inc., Armonk, New York US. For compare the values of the means from two samples, paired samples t test were used. For compare the relationship between the two samples correlation was used mean and standard deviation are calculated for Teichholz method’s end diastolic volume (EDV), end systolic volume (ESV) and Simson method’s end diastolic volume (EDV), end systolic volume (ESV). The critical value of “p” indicating the probability of significant differences was taken as <0.05 for comparison. Scatter plot graph were used for correlation in figure 1. Box plot graph were used for graphical representations in figures 2 and 3.

**Results:** Ejection fraction measurements obtained with both the Teichholz and Simpson’s methods are directly comparable for evaluation of ejection fraction. This study is done to compare Teichholz method to simpson’s method in patients with global hypokinesia of left ventricle. From the total subjects, 105 patients were male and 45 were females. In this study, we compare Teichholz method.
to Simpson’s method in patients with global hypokinesia of left ventricle. In this study, 150 patients who underwent echocardiography in CSSH were take Out 150 patients 105 were male (70%) and 45 were female (30%). 38% (57) patients falls under the age group of 60-69 and 25% (38) falls under the age group of 50-59.58% (86) of patients in Teichholz method and 55% (82) of patients in Simpson’s method had moderate left ventricular dysfunction. The mean value calculated by the Simpson’s method did not differ significantly from the mean value calculated by the Teichholz method.

Table 1: Correlation between the Teichholz method left ventricular ejection fraction (LVEF) percentage and Simson method left ventricular ejection fraction percentage.

<table>
<thead>
<tr>
<th>LVEF%</th>
<th>TEICHHOLZ’S LVEF%</th>
<th>SIMPSON’S LVEF%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pearson correlation</td>
<td>1</td>
<td>.0825**</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td></td>
<td>0.000</td>
</tr>
<tr>
<td>N</td>
<td>150</td>
<td>150</td>
</tr>
</tbody>
</table>

Table 2: The following table shows the association between the Teichholz and Simpson’s method of LVESV and LVEDV. Paired samples t test

<table>
<thead>
<tr>
<th>Pair 1</th>
<th>Mean</th>
<th>N</th>
<th>SD</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>TEICHHOLZ’S LVESV</td>
<td>114.6953</td>
<td>150</td>
<td>35.309</td>
<td>0.000</td>
</tr>
<tr>
<td>TEICHHOLZ’S LVEDV</td>
<td>166.6884</td>
<td>150</td>
<td>51.098</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Pair 2</th>
<th>Mean</th>
<th>N</th>
<th>SD</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>SIMPSON’S LVESV</td>
<td>116.6247</td>
<td>150</td>
<td>33.187</td>
<td>0.000</td>
</tr>
</tbody>
</table>

**. Correlation is significant at the 0.01 level (2-tailed). Teichholz methods LVEF% and Simson’s method’s LVEF% have a statistically significant linear relationship (p<0.001). The direction of relationship is positive (i.e., Teichholz and Simson method LVEF% are positively correlated), meaning that these variables tend to increase together (i.e., greater LVEF% is associated with greater weight).

Figure 1: The following Scatter plot graph shows the Teichholz method’s LVEF% and Simson method’s LVEF% are positively correlated.
Discussion: Ejection fraction is the percentage of blood leaving from heart for each contraction. Ejection fraction is usually measures only in Left Ventricle. Common test to assess Left Ventricular Ejection Fraction is the echocardiogram; Left ventricular Ejection fraction is assessed by measuring the difference between End Diastole and End systole value divided by the End diastole value. In this study we have compare the teichholz and simpson’s method for assessing the left ventricular ejection fraction in patients with no regional wall motion abnormality. Teichholz method is inferior to simpson’s method in patients with regional wall motion abnormality like septal or inferior wall hypokinesia. But Teichholz method is non inferior in patients with global hypokinesia of left ventricle. In this study, 150 patients who underwent echocardiography in CSSH were taken. Out 150 patients 105 were male (70%) and 45 were female (30%). 38% (57) patients falls under the age group of 60-69 and 25% (38) falls under the age group of 50-59.58% (86) of patients in Teichholz method and 55% (82) of patients in Simpson’s method had moderate left ventricular dysfunction.

Conclusion: In this study it has been noted that teichholz method is non inferior in patients with global hypokinesia of left ventricle.

References:


http://doi.org/10.36295/ASRO.2020.232215


6. Mor-Avi V, Jenkins C, Kuhl HP. Real-time 3-dimensional echocardiographic quantification of left ventricular volumes: multicenter study for validation with magnetic resonance imaging and investigation of sources of error.

7. Chukwu EO, Barasch E, Mihalatos DG. Relative importance of errors in left ventricular quantitation by two-dimensional echocardiography: insights from three-dimensional echocardiography and cardiac magnetic resonance imaging.

8. Grossgasteiger M, Hien MD, Graser B. Assessment of left ventricular size and function during cardiac surgery: an intraoperative evaluation of six two-dimensional echocardiographic methods with real-time three-dimensional echocardiography as a reference.