

ORIGINAL RESEARCH ARTICLE

LEFT VENTRICLE EJECTION FRACTION ESTIMATION BY POINT OF CARE ECHOCARDIOGRAPHY IN PATIENTS ADMITTED IN INTENSIVE CARE UNIT

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ABSTRACT

Background: Point of care ultrasonography (POCUS) by non-cardiologist is a safe and rapidly evolving diagnostic modality for the assessment of left ventricular ejection fraction (LVEF). This study aims to correlate the eyeball estimation of LVEF (EBEF) with modified Simpson's method and linear measurement in M-mode parasternal long axis view (PLAX).

Methods: A descriptive cross-sectional study was conducted at Chitwan Medical College. POCUS was performed in all ICU patients on the day of admission with optimal image acquisition and LVEF was estimated by three different methods and correlation of results were analyzed.

Results: Out of total 52 patients studied, median age was 58.38 ± 17.58 years (range: 24 – 89 years). There were 28 males (53.8%) and 24 females (46.2%) in this study. LVEF measured by eyeballing method and modified Simpson's method had excellent correlation (Pearson's correlation coefficient $r = 0.956$, $P < 0.001$). However, there was only a good correlation ($r = 0.882$, $P < 0.001$) between linear measurement method in M-mode view and Simpson's method. It was found that eyeballing method underestimates EF as measured by Simpson's method by an average of 2.33% (95% CI: 1.12 – 3.55%). Similarly, EF measurement by linear method overestimates EF as compared to results observed by Simpson's method by an average of 6.57% (95% CI: 4.87 – 8.27%).

Conclusions: Excellent correlation was observed between EBEF and modified Simpson's method while linear measurements in M-mode may give incorrect estimation of EF especially in patients with regional wall motion abnormality.

INTRODUCTION

The critically ill patient is under an intense threat for life. Therefore, the diagnostic methods used in the critical care unit must be fast, reliable and reproducible to assure a successful therapeutic strategy. The routine use of point of care ultrasonography (POCUS) by non-cardiologist for rapid, bedside assessment of the ejection fraction in critically ill patients guide the intensivists to potentially expedite and provide cost-efficient, high-value care.¹ Recent studies have found that clinical management involving the early use of POCUS is accurate for the diagnosis thereby reducing physician's diagnostic uncertainty, and guides us in changing the management and resource utilization.²

In the ICU environment, limited training of non-cardiologist residents without previous knowledge in ultrasound appears feasible and efficient to address simple limited clinical questions using point-of-care echocardiography.³ Intensivists were able to estimate LV function with reasonable accuracy in the ICU, despite having undergone minimal training in image acquisition and interpretation.⁴ The rapid, bedside determination of LV function to assist in diagnosis and management of patients in the ICU has shown to be acceptable: clinicians with minimal

training in cardiac ultrasound have been shown to be capable of assessing LV function with reasonable accuracy, with agreement with a blinded cardiologist's interpretation.^{4,5} This study was done to estimate the left ventricular ejection fraction of patients admitted in intensive care unit (ICU) of Chitwan Medical College Teaching Hospital (CMC-TH) with different methods and correlate the findings between these methods.

METHODS

This descriptive, cross-sectional study was conducted between October and December 2019. Ethical approval from IRC (Ref. No: CMC-IRC/076/077-047) prior to the study. All patient involved in the study was informed and necessary consent was taken from them or from the relatives if patient was unable to give consent. Point of care transthoracic echocardiographic examinations was performed on the first day of admission to estimate baseline left ventricular ejection fraction (LVEF), using M-Turbo Sonosite Ultrasound system, using cardiac probe (3.5 MHz).

Depending upon the condition of patient, the positioning of patient for bedside echocardiography and optimal image ac-

quisition was done as possible. LVEF was estimated by three methods at bedside; viz eye-ball estimation, modified Simpson's biplane disc method and M-mode linear measurement in left parasternal long axis view.

Left parasternal long axis and apical views were obtained with the patient in a left lateral recumbent position or supine position as permitted by the patient condition. Eyeballing ejection fraction (EBEF) and chamber wall motion were evaluated using 2D images in the long-axis, short-axis and apical four- and two-chamber views. EBEF was visually estimated by observing inward motion of endocardium, thickening of myocardium, longitudinal motion of mitral annulus, and geometry of ventricle. Regional wall motion abnormality was assessed according to the cardiac chamber wall segments affected. A value of LVEF was then determined by eyeballing estimation. Modified biplane Simpson's LVEF were measured in frozen sections of apical four and two chambers views by tracing of the endocardial borders of left ventricle at end diastole and end systole. Left ventricular ejection fraction is then derived by the formula:

$$\text{LVEF} = \frac{\text{LVEDV} - \text{LVESV}}{\text{LVEDV}} \times 100\%$$

There has to be good image quality with visible endocardial contour to trace the area in end diastole and end systole. Normal EF: >55%, Mild: 45-54%, Mod: 30-44%, and Severe: <30%.

Left ventricular ejection fraction by M-mode linear measurement in left parasternal long axis (PLAX) view was done by the transducer positioned on the left sternal edge in 2nd-4th space with the marker dot pointing towards the right shoulder. Transducer was adjusted as needed to get the best possible PLAX view. After acquisition of the satisfactory view, M-mode cut was taken at the level of tips of mitral valve leaflets and estimation of ejection fraction was done by measurement of septal and posterior wall thickness, and left ventricular diameter in end-diastole and systole using the software in-built in the M-Turbo Sonosite ultrasound system.

Data was recorded in structured Proforma and SPSS 16 was used for analysis. P value of <0.05 was considered significant for the study.

RESULTS

The mean age of the patients (n = 52) was 58.38 ± 17.58 years (Range: 24 – 89 years). There were 28 males (53.8 %) and 24 females (46.2 %). The commonest working diagnosis was COPD with type 2 respiratory failure (9.6 %), followed by alcoholic liver disease, chronic kidney disease and diabetes mellitus (5.8% each). Comorbidities were present in 34/52 patients (65.4%), the commonest being hypertension. Only 27 (51.9%) were non-smokers, 17 (32.7%) were ex-smokers and 8 (15.4 %) were current smokers. The median pack years of smoking was 15 pack years (Range: 6 – 34 smoking pack years). Regional wall motion abnormality (RWMA) was present in 9/52 (17.3%) patients and only 5/52 (9.6 %) were treated with inotropes.

Agreement between 3 different methods for ejection fraction

(%) estimation namely eyeballing method, Simpson's method and linear measurement method in M-mode PLAX view was present. There was a good correlation between all the 3 measurement methods. EF measured by eyeballing method and modified Simpson's method had excellent correlation (Pearson's correlation coefficient (r) = 0.956, P<0.001) (Figure 1). However, there was only a good correlation (r= 0.882, P<0.001) between M-mode PLAX view linear measurement and modified Simpson's method (Figure 2).

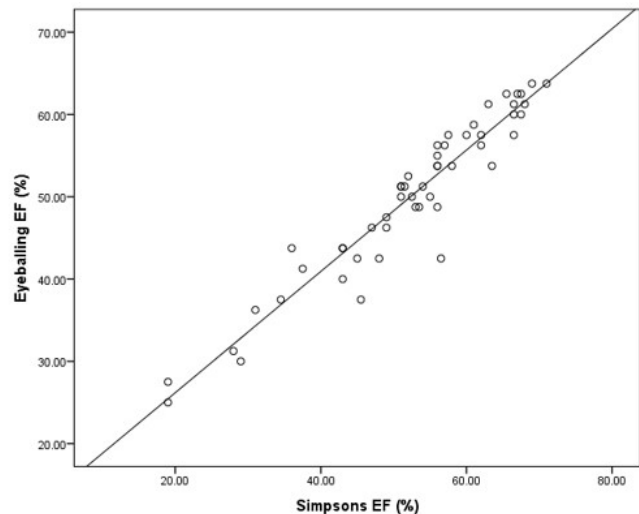


Figure 1: Correlation between eyeballing method and Simpson's method

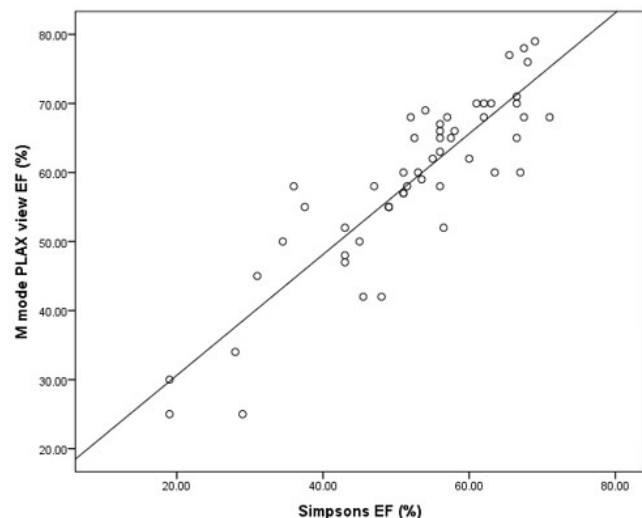


Figure 2: Correlation between EF in M-mode PLAX view and Simpson's method

There was a reasonable level of agreement between eyeballing method and Simpson's method. However, it was found that eyeballing method underestimates EF as measured by Simpson's method (considered as the gold standard here) by an average of 2.33% (95 % CI: 1.12 – 3.55%) (Table1).

Similarly, linear measurement method of EF in M-mode PLAX view overestimates EF as measured by Simpson's method by an average of 6.57% (95 % CI: 4.87 – 8.27%) (Table1).

Table 1: Mean difference between the 3 different methods for EF (%) estimation (Paired sample t-test)

Method of estimation	Mean EF (± SD)	Mean difference (95 % CI)
Eyeballing method	50.09 ± 9.73	EBEF-Simpson's method -2.33 (-3.55 - -1.12)
Simpson's method	52.43 ± 12.61	
M-mode PLAX view method	59.00 ± 12.51	M-mode PLAX method- Simpson's method 6.57 (4.87 – 8.27)

On further agreement analysis between Eyeballing method and Simpson's method (Bland-Altman plot analysis), there was a fluctuation observed during estimation. Although eyeballing method underestimated EF in general, it interestingly overestimated at lower EFs values (EF < 40%) as shown in (Figure3).

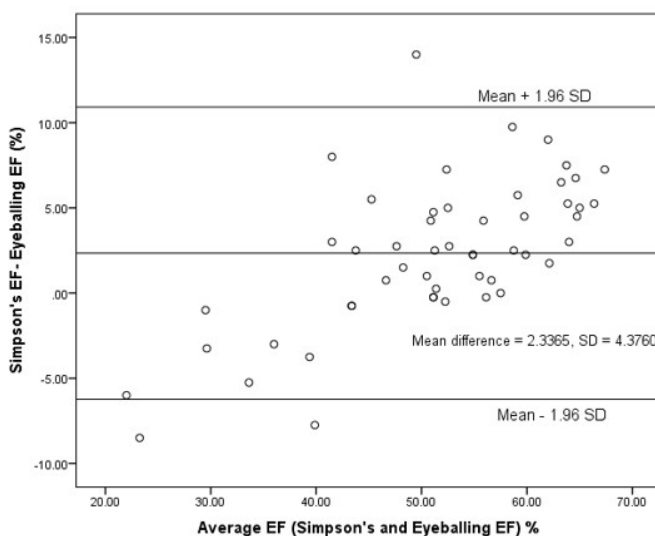


Figure 3: Agreement analysis between Eyeballing method and Simpson's method (Bland-Altman plot analysis)

DISCUSSION

The mean age of the patients (n = 52) was 58.38 ± 17.58 years (Range: 24 – 89 years). There were 28 males (53.8 %) and 24 females (46.2 %). Study conducted by Hiroe K et al in 70 patients found that correlation between visual EF and Simpson's EF was (r=0.90, 95% CI= -0.1±10.0%) was good however inexperienced observer resulted in poor correlation of ejection fraction.⁶

Shahgaldi K et.al, measured EF in 30 patients using quantitative real-time three-dimensional echocardiography as the reference method and compared with EBEF by two and triplane echocardiography. They reported EF was 54.7 ± 8.9% by the reference method, whereas eyeballing EF by two dimensional and triplane echocardiography were 55 ± 8%, 55 ± 9% respectively which were statistically not significant between these estimations.⁷

Sievers B, et. al, observed in 100 subjects that LVEF was underestimated by the eyeballing EF compared to the quantitative method using 1.5-T cardiovascular magnetic resonance imager but was also not significant. They concluded that the visual approach for EF assessment may be used for rapid assessment of left ventricular function in clinical practice where accuracy is of less concern.⁸

In this study 52 ICU patients were enrolled and left ventricular ejection fraction was estimated by 3 different methods: eyeballing ejection fraction, modified Simpson's method and linear measurements in M-mode PLAX view. Eyeballing ejection fraction which was measured on real-time imaging of multiple sections, correlated closely with modified Simpson's quantitative methods for the evaluation of left ventricular ejection fraction. The results of the present and prior studies suggest that eyeballing ejection fraction could be accepted for routine use in clinical practice, provided that the variability of eyeballing ejection fraction is low.

The M-mode linear measurement in PLAX view consistently showed higher values for left ventricular ejection fraction in this study. The reason for this could be that our study had small number of samples with basal regional wall motion abnormalities (basal septal and basal posterior walls) from where M-mode linear measurements in PLAX view were taken.

Since all the methods were evaluated by the same person, which could have introduced some bias. This type of bias is unlikely to explain the good correlations between eyeballing ejection fraction and modified Simpson's method left ventricular ejection fraction estimation observed in the present study. Bias based on the visual impression of the left ventricular ejection fraction is however impossible to completely avoid. Even left ventricular ejection fraction based on tracing of the endocardial borders is affected by the visual impression in formal quantitative study. Limitations of this study are small sample size, single-center study, and operator biasness should be considered. Moreover, various treatment methods (eg. use of inotropes, patients on mechanical ventilation) and disease condition (chronic kidney disease with reduced EF, cardiac disease) may influence the assessment of left ventricular ejection fraction.

CONCLUSION

Eyeballing ejection fraction correlated significantly with modified biplane Simpson's method for the evaluation of left ventricular systolic function. Since bedside echocardiography can be readily and quickly performed, eyeballing ejection fraction estimation can be a useful echocardiographic method for the assessment of left ventricular systolic function in critical care setting where formal quantitative estimation of left ventricular ejection fraction may not be possible.

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