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Assessment of inferior vena cava diameter by echocardiography in normal Indian population: A prospective observational study

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ABSTRACT

Background: The assessment of the IVC diameter is self explanatory for evaluation of the individuals' volume status. Studies regarding IVC diameter estimation in normal individuals are scarce.
Aim: The present study aimed to define normal criteria of size and dynamics of the inferior vena cava (IVC) by M-mode echocardiography in normal individuals.
Methods: This was a prospective, single-center, observational study carried out at Sri Jayadeva Institute of Cardiovascular Sciences and Research between December 2011 and April 2014. A total of 4126 consecutive individuals were enrolled. Normal IVC diameter was measured both during inspiration and expiration by M-mode echocardiography in subcostal view.
Results: The IVC diameter varied from 0.46 to 2.26 cm in the study individuals. The IVC diameter ranged from 0.97 to 2.26 cm during expiration and from 0.46 to 1.54 cm during inspiration. A strong correlation was observed between IVC diameter and height, weight and BMI of the individuals, calculated using Pearson correlation. The correlation coefficients for expiratory and inspiratory IVC diameters as a function of BMI were 0.686 and 0.7, respectively.
Conclusions: Our findings corroborate the correlations between height, weight and BMI with IVC diameter. Future studies could be focused to bring about a steadfast formula for calculating IVC diameter based on demographic parameters of an individual.

1. Introduction

Echocardiography assists complete estimation of cardiac function. Through echocardiography, inferior vena cava (IVC) can easily be depicted by a transthoracic, subcostal view.[1]

Assessment of IVC diameter in different phases of respiratory cycle is a consistent guide for assessment of volume status in the haemodynamically stable individuals. In a spontaneously breathing, healthy subject, cyclic variations in pleural pressure can cause variation of inferior vein cava diameter. The echocardiography can be used as a reliable tool for this purpose.[2] The measurements and indices that could be useful are IVC diameter and IVC collapsibility index.

The IVC is a major collapsible vein; its diameter directly relates to right side cardiac functions.[3] Literature suggests that IVC and collapsibility index of patients correlate with their intravascular volume.[4] Moreover, it reproduces volume status more precisely than other parameters based on arterial system such as blood pressure, pulse rate, diameter of aorta, and others.[5]

Studies in the past have utilized IVC diameter in monitoring volume status in patients undergoing haemodialysis, in patients under mechanical ventilation in intensive care units,[5,6] in patients with severe sepsis, severe preeclampsia, acute circulatory failure, sub-arachnoid hemorrhage,[7] and heart failure.[8] However, the IVC diameter in normal population has not been quantified. As the use of the degree of collapsibility of the IVC in conjunction with IVC diameter offers more accurate non-invasive information regarding right atrial pressure.[9–11] Its assessment in normal individuals poses a great importance in clinical assessment of the individuals. Thus we conducted this study to define normal criteria of size and dynamics of the IVC based on age, height, weight and body mass index (BMI), by M-mode echocardiography in normal individuals.

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2. Methods

2.1. Study design and patient population

This was a prospective, single-center, observational study in which 4126 consecutive individuals were enrolled at Sri Jayadeva Institute of Cardiovascular Sciences and Research between December 2011 and April 2014. The study complies with Declaration of Helsinki and was approved by the institutional ethics committee.

Individuals eligible for inclusion were healthy, above the age of 18 years and had structurally normal heart with normal left ventricular ejection fraction (LVEF). In all the individuals' clinical examination, ECG and chest X-ray were normal. The study population did not have any other clinical, electrocardiographic, or echocardiographic evidence of increased right atrial pressure (RAP). Right atrium and right ventricle (RV) were normal in size and RV contractility was normal. There was no regional wall motion abnormality in any of the individuals. Subjects were excluded if they had ischemic heart disease (IHD), IHD combined with LV dysfunction or decompensated heart failure, rheumatic heart disease, mitral regurgitation, mitral stenosis, aortic stenosis, aortic regurgitation, chronic lung disease, constrictive cardiomyopathy, restrictive cardiomyopathy and dilated cardiomyopathy.

2.2. Study methods

Conventional echocardiography (HD7xe, Koninklijke Philips N.V., Amsterdam, Netherlands) was performed in all the individuals. The IVC diameter was visualized, with individuals in supine position, using subcostal 4 chamber view (midline, inferior to the xyphoid, angling to the right). The technique was performed using 2–4 MHz transducer. The transducer was placed immediately below the xiphisternum and 1–2 cm to the right of the midline, in such a way that the marker dot points toward the sternal notch. The cross-section image of IVC was visualized at the right atrial/hepatic vein/IVC junction and rotated counter-clockwise so that long axis view of IVC merging into right atrium was obtained. Once the 2-dimensional image of IVC entering into right atrium was acquired, then the M-mode line was placed through IVC, 1 cm caudal from its junction with hepatic vein, and M-mode tracing was attained. This ensured that we did not measure intrathoracic IVC during any part of the respiratory cycle. Individuals were asked to take several short sniffs during M-mode recording. Since, normal inspiration may not elicit the inspiratory response; brief sniffs are often required, as this leads to a rapid and distinct decrease in IVC size.[12] In each of the individual, IVC diameter was recorded both during inspiration and expiration. The M-mode image was freezed, using calipers measurements of maximum and minimum diameter of IVC were made. All individuals were subsequently grouped as per their inspiratory IVC diameter and expiratory IVC diameter. Then the grouped individuals were correlated with their corresponding age, height, weight, and BMI.

2.3. Statistical analysis

The continuous variables were presented as mean, standard deviation and ranges. The correlation between IVC diameter and collapsibility index as a function of demographic parameters was calculated using Pearson correlation coefficient. A p-value of ≤ 0.05 was considered statistically significant. Scatter plots of expiratory and inspiratory IVC diameter of individuals against BMI and all data were analyzed using the Statistical Package for Social Sciences (SPSS, Chicago, IL, USA) program, version 15.

3. Results

Out of 4126 individuals enrolled for the study, 2336 (56.62%) were male. During inspiration, the IVC caliber decreased in every individual. The decrease was quite variable and dependent on individual characteristics. Expiration led to increase in the IVC diameter in all individuals. Fig. 1 demonstrates echocardiography

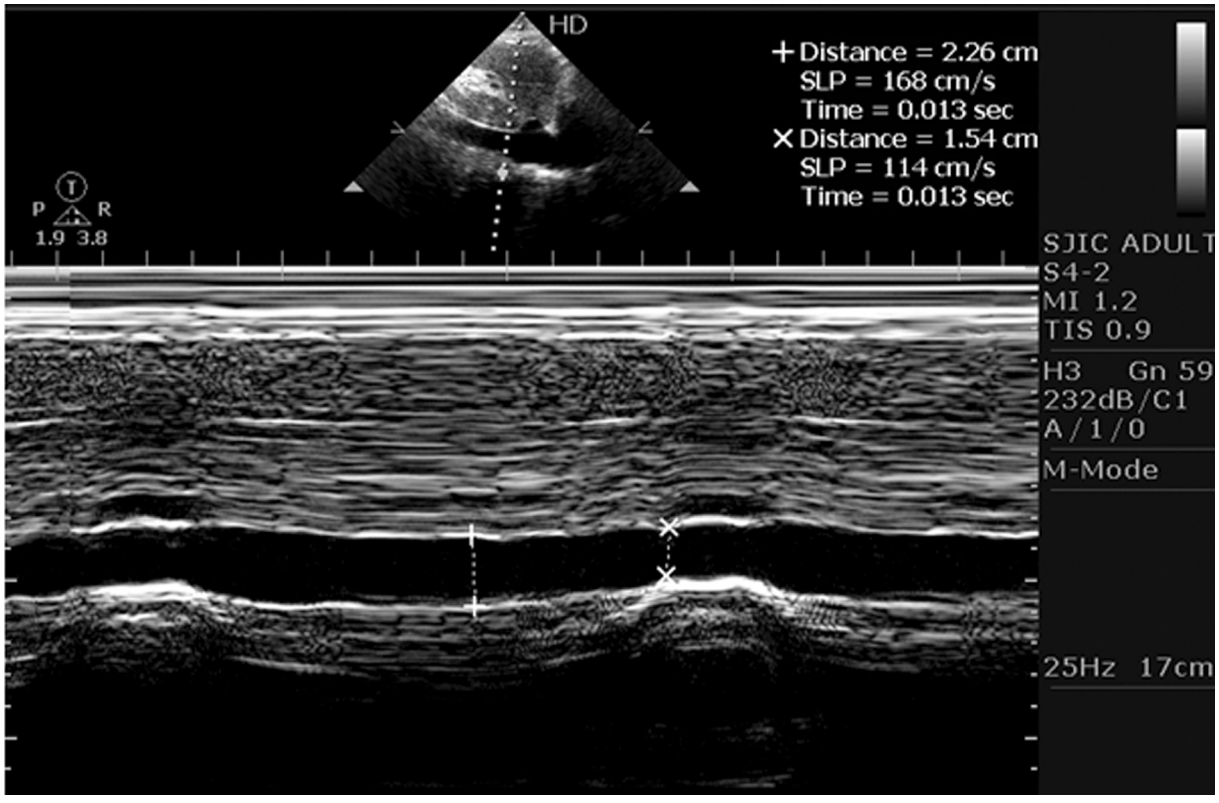

Fig. 1. Echocardiography image showing changes in IVC diameter during expiration and inspiration in an individual.

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