

Research Article

Expiratory Diameter of the Inferior Vena Cava Diameter IVC Across Age Groups in CCF Subjects

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Abstract

Background: Dilatation of the Inferior Vena Cava (IVC) is used as the ultrasonic diagnostic feature in patients suspected of congestive heart failure. The IVC diameter has being reported to vary among the various age ranges. Knowledge of these variations is useful in precision diagnoses of CHF by imaging scientists.

Aim: The study aimed to determining the ultrasonic mean expiratory diameter of the IVC across the various age ranges with CCF in Azare, Bauchi State-Nigeria.

Methods: One hundred and ninety-nine subjects of both sexes diagnosed with Congestive Cardiac Failure were randomly grouped into six age groups. A structured questionnaire was used to rule out those that fell within the exclusion criteria. Their informed consent was sought for abdominal ultrasound scan. The probe was placed on the mid line of the body, half-way between the xiphoid process and the umbilicus with the marker on the probe directed towards the patient's head to obtain a longitudinal view of the IVC. The maximum IVC diameter was measured from the subcostal view using the electronic caliper of the scan machine during expiration on a B mode. The mean value of each group was obtained and analyzed statistically.

Results: It was observed that, the mean expiratory diameter of the IVC across the age group (18-27, 28-37, 38-47, 48-57, 58-67 and 68-77) years were (1.89, 1.96, 1.94, 2.06, 1.91, 1.97 and 1.94) cm, respectively P-value ≤ 0.05 .

Conclusion: In conclusion, the normal cutoff values for indicating a dilated IVC across the different age strata in the populace has been established.

Keywords: Ultrasonic; IVC Diameter; Age Group

Introduction

Congestive Cardiac Failure (CCF) is a pathological condition caused by excessive accumulation of fluid within the heart principally due to ischemic and non-ischemic conditions leading to deficient venous return and by extension, dilatation of the IVC [1].

Expansion of the Inferior Vena Cava (IVC) is used as the ultrasonic diagnostic feature in persons suspected of congestive heart failure [2]. Several reports revealed that the IVC diameters are at variance with age. Pecolli, et al., reported that patients with heart failure in the highest tertile of IVC diameter were older; had lower body mass index. However, no known study of this nature has been carried out across the different age groups in this study location. Knowledge of these differences is helpful in accurate diagnoses of CHF by imaging scientists. Ultrasound scanning machine is useful in the evaluation of portosystemic

diseases like congestive cardiac failure [3]. In ultrasound examination, the anatomical structure of focus in diagnosing patients queried of heart failure is the inferior vena cava [2]. The use of ultrasound to accurately diagnose some critical pathological condition, such as porto systemic diseases like congestive cardiac failure often puzzles sonographers especially amateurs in the field and as such, they require great care, confidence among other factors in the use and manipulation of equipment apart from having a thorough knowledge and understanding of the anatomy of the inferior vena cava and it's pathophysiology in other to make reasonably accurate diagnoses of congestive cardiac failure [4].

Materials and Methodology

The following materials were used for the study.

A stadiometer, Sono-crown ultrasound machine, 3.5 MHZ of linear probe (transducer), gel, sono-printer and questionnaires.

Experimental Design

Participants were grouped into six (18-27, 28-37, 38-47, 48-57, 58-67 and 68-77) years (Table 1).

Age Range (Years)	Mean IVC Diameter (cm)
(18-27)	1.89
(28-37)	1.96
(38-47)	1.94
(48-57)	2.05
(58-67)	1.91
(68-77)	1.97

Table 1: Methodology of research for age ranges in the CCF subjects.

Sample Size

A survey was done using systemic random sampling technique and sample size was deduced using Yamane equation (2008 as indicated below: $n_y = N / (1 + Ne^2)$). Where n_y is sample size, N is Population size and e is alpha level = 0.05 (If confidence interval is 95% or 0.95).

The population of Azare, Bauchi was estimated at 411,700 (National Population commission, 2020) Three hundred and ninety-nine (399) was obtained as sample size and one hundred and ninety-nine were diagnosed with CCF (Fig. 1).

Study Location



Figure 1: The Nigerian map is the geographical site of Azare, Bauchi, State. Azare is located in katagum, Bauchi, Nigeria. It's geographical coordinates are 110 40` 42`` North, 100 11` 31`` East (Maplandia.com).

Sonographer/Ultrasound Unit

The ultrasound unit of Shifa`a Medical Centre, General Hospital and Federal Medical Centre all of Azare, Bauchi State were used for the study and the measurements were taken alongside with a certified and competent sonographer or a radiologist between April to December, 2020.

Inclusion Criteria

1. All persons between the ages of 18 and 77 years and apparently healthy
2. All persons without CCF (normal or healthy subjects)

Exclusion Criteria

1. All persons below the age of 18 years and above 77 years
2. All persons with known hepatobiliary diseases like splenomegally, history of cholecystectomy or cardiac operation
3. All persons diagnosed of CCF that are either on treatment or not.
4. All pregnant women
5. All persons with obvious anatomical defect

Patient and Methods

A randomly selective prospective study was carried out at Shifa`a Medical Centre, General Hospital and Federal Medical Centre all in Azare, Bauchi State between March to December, 2020. One hundred CCF patients comprising male and female subjects, aged between eighteen and seventy-seven were randomly selected and grouped into six (18-27, 28-37, 38-47, 48-57, 58-67 and 68-77) years. A structured questionnaire was used to help rule in those that fell within the inclusion criteria. They were subjected to abdomino-pelvic ultrasonography for assessment of the Inferior Venae Cava (IVC) diameter in both inspirational and expiratory phases.

Experimental Procedures

Each subject was placed in a supine position and was encouraged to fast overnight in order to decrease the amount of bowel gas which may obscure the target structures. Male subjects were requested to put off their tops while female subjects were required to raise their tops, up to the sub costal margin. The abdomen preset was clicked on the ultrasound machine which is the recommended interphase for examining abdominal structures. A low frequency probe (3.5 MHZ), that is, curvilinear transducer was used with an ultrasound gel applied on it.

Positioning and Probe Selection

The probe was placed on the mid line of the body, half-way between the xiphoid process and the umbilicus with the marker on the probe directed towards the patient`s right side to obtain a transverse view. The IVC appears as an elliptical or "tear drop" structure on the right side of the patients mid line while the aorta appears on the left side. The IVC appears compressible under gentle pressure and not as pulsatile as the aorta. The probe was rotated longitudinally in clockwise direction to ninety degrees with the marker on the probe directed towards the head of the patient to obtain the longitudinal axis of the IVC. The long axis of the IVC was seen clearly below the xiphoid process with a branch of the hepatic vein draining into it. As shown below. The maximum IVC diameter was measured from the subcostal view with the IVC displayed along its long axis in accordance with the method of Lang, et al., Kawata, et al., and Yusuf, et al., [4-6]. The diameter was measured immediately caudal to the junction of the hepatic vein with the IVC and approximately 1-2 cm caudal to the junction of the IVC and the ostium of the right atrium as shown in Fig. 2,3.

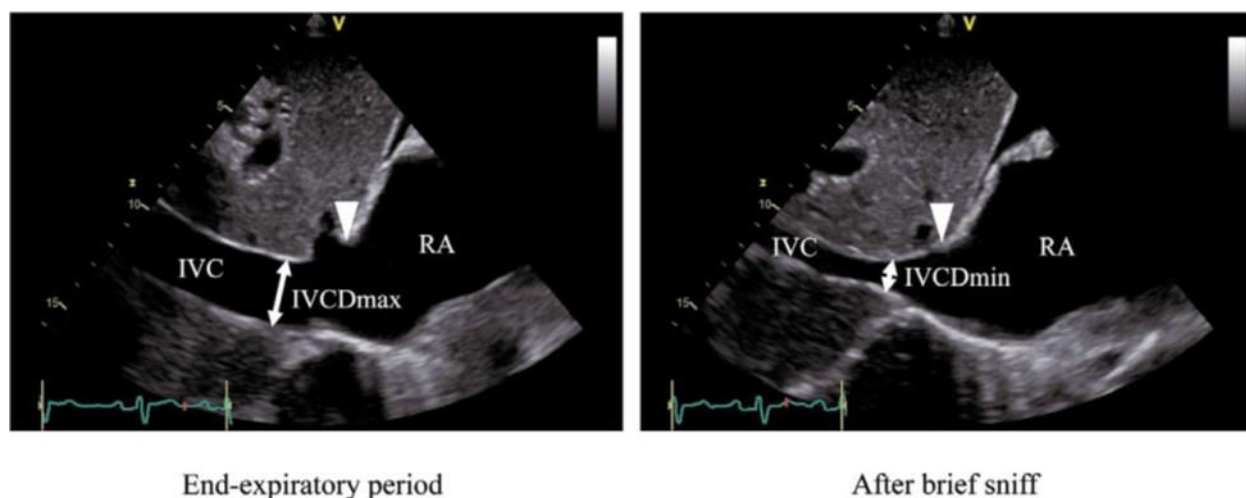


Figure 2: Example of IVC ultrasound in the subcostal long axis view: Arrow head indicates the IVC-RA junction. IVC: Inferior Vena Cava; RA: right atrium [5].



Figure 3: Image of the inferior vena cava (transverse view) old male obtained for inferior vena cava diameter emment from an ultrasonographic scan of the subject in Plate V Arrow indicates Anterior-Posterior (AP) diameter of the IVC [6].

Blood Pressure (BP) Measurements

The subject's blood pressures were obtained in accordance with WHO guidelines 2021. Those with blood pressure above 120/80 (mmHG) were considered as unhealthy subjects.

Statistical Analysis

Data obtained were expressed as mean $\pm$ (SEM) standard error of mean, Analysis of Variance (ANOVA) was used to compare the mean difference between and within the groups and the level of significance was set at $p \leq 0.05$, and a 95% confidence interval was applied to the numerical variables which are normally distributed. Statistical analysis was carried out using Statistical Package for Social Science (SPSS) Version 20.

Results

Mean expiratory diameter of the IVC among age ranges in CCF Subjects. An Analysis of Variance (ANOVA) was carried out to determine the mean values of the ultrasonic inferior vena cava diameter among the various age ranges and to investigate the level of significant differences in the mean diameter of the IVC in the various age ranges as well, that is, between the groups.

Table 2 shows that, the ultrasonic mean diameter of the age ranges (18-27, 28-37, 38-47, 48-57, 58-67 and 68-77) years were (1.89, 1.96, 1.94, 2.06, 1.91, 1.97 and 1.94) cm, respectively. Table 3 shows that the mean expiratory diameters of the ultrasonic Inferior Vena Cava (IVC) in the various age groups were not significantly different from each other P-value ≤ 0.05 , η^2 (Eta square value) = 0.04 (Table 3).

Age Range (Years)	Mean IVC Diameter (cm)	Std. Deviation
(18-27)	1.89	0.31
(28-37)	1.96	0.18
(38-47)	1.94	0.26
(48-57)	2.05	0.12
(58-67)	1.91	0.26
(68-77)	1.97	0.46
* = indicates were significant differences lie. P- value: < 0.05		

Table 2: Mean expiratory diameter of the inferior vena cava among age ranges in the CCF subjects.

IVC DIAMETRE	SUM of SQUARES	df	Mean Square	F	Sig
BETWEEN GRPS.	0.095	5	0.019	0.28	0.9
WITHIN GRPS.	2.32	34	0.068		
TOTAL GRPS.	2.43	39			
Note effect size = η^2 = sum of square between/sum of square total = 0.04					

Table 3: Analysis of variance in the ultrasonic expiratory mean diameter of the Inferior Vena Cava (IVC) among the various age range.

Discussion

The observed indifference in the ultrasonic mean diameter of the IVC across the increasing age groups in the study was not in line with the findings of Pellicori, et al., who reported that among the 693 patients enrolled for a similar study, median age was 73 years, 33% were women and 568 had heart failure. Patients with heart failure in the highest tertile of IVC diameter were older; had lower body mass index [7-14]. The possible reason for this could be attributed to the mean/median age used in the work of Pellicori, et al., were quite different from that, used in the present study. The sample size (693) patients were quite higher than the sample size used in this study. This means that cardiovascular risk factors, the mean age and sample size may also affect the IVC diameter of an individual.

Conclusion

It can be concluded from this study that:

1. The ultrasonic mean expiratory diameter of the Inferior Vena Cava (IVC) across the age groups (18-27, 28-37, 38-47, 48-57, 58-67 and 68-77) years were (1.89, 1.96, 1.94, 2.06, 1.91, 1.97 and 1.94) cm, respectively.
2. No significant differences existed in the ultrasonic mean diameter among the different age groups (P-value = 0.713). η^2 (Eta square value) = 0.04.

Conflict of Interest

The authors have no conflict of interest to declare.

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