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# Evaluation of Normal Inferior Vena Cava Diameter by Multidetector Computed Tomography

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## ABSTRACT

**Background and purpose:** Knowledge of the normal diameters of the IVC is important regarding the detection of the abnormality and valuable in the treatment of patients suffering from traumatic shock. There is sparse literature about the evaluation of normal inferior vena cava diameter. We aimed to derive a range of measurement in inferior vena cava diameter.
**Materials and methods:** This prospective cross-sectional study was undertaken to evaluate the diameters of the IVC as well as their association to gender and age. The study was performed 163 patients (77 males and 86 females) with a mean age of 51.09 years, free of cardiac and renal congenital disease, who were referred for abdominal CT to Department of Radiology and Imaging of Tribhuvan University Teaching Hospital, Kathmandu from January 2021 to May 2021.Anteroposterior (AP) and transverse (T) diameters of the IVC were measured just above the renal vein.
**Results:** This study revealed that the mean± standard deviation (SD) of the anteroposterior (AP) diameter of the IVC in men measured was 14.81±2.03 mm, 15.84±2.22 mm in women. The mean± standard deviation (SD) of the transverse (T) diameters, measured were 26.02±2.77mm in women and 26.60±2.63mm in men.
**Conclusion:** The information provided in this study will allow clinician to detect and accurately characterize IVC abnormalities which will guide in clinical decision making and improving patient care. Future studies should focus on large scale multicenter enrollment.

***Keywords:*** CT scan, Inferior Vena cava, Diameter, Anteroposterior, Transverse,

## INTRODUCTION

The inferior vena cava (IVC) is the main conduit of venous return to the right atrium from the lower extremities and abdominal viscera. It can be a source of critical information for referring clinicians, and recognition of IVC variants and pathologic characteristics can help guide patient treatment. Because computed tomography (CT) is used to evaluate a wide variety of abdominal symptoms, it is likely to be the most common imaging modality for initial detection of IVC variants and pathologic findings. Routine abdominal imaging at 60–70 seconds after intravenous administration of contrast material (portal venous phase) shows enhancement in the renal and suprarenal IVC but may also show admixture artifact in the infrarenal IVC [1,2]. Increasing the delay after contrast material injection to 70–90 seconds allows more uniform enhancement of the entire IVC at CT [2]. The end points of resuscitation in trauma patients are difficult to define yet under-resuscitated patients continue to have a higher incidence of

cardiovascular collapse and multi-organ failure [3,4]. During periods of tissue hypoxia, ATP production occurs via the anabolic pathway resulting in the production of lactate and hydrogen ions. Thus, lactate is often used as a marker of ongoing shock [5,6]. The size of the inferior vena cava (IVC) on CT scan has the potential to be an indicator of volume status in trauma patients. A few case series suggest that the IVC can be a useful in suggesting of volume status in dialysis patients [7]. One study found that six of seven patients who had a flat IVC on CT scan following abdominal trauma were hypovolemic [8]. However, a retrospective review of 500 patients who underwent abdominal CT scans for a wide variety of reasons found that 70 of them had a flat IVC.

## MATERIALS & METHODS

This prospective cross-sectional study was conducted in the Department of Radiology and Imaging, Tribhuvan University Teaching Hospital, Kathmandu, Nepal between the periods from Janaury2021 to May 2021. It was descriptive research study done on 163 (77 male and 86 females) patients who underwent contrast enhanced Computed Tomography of abdomen in the department. Purposive sampling technique was used.

All the patient's undergoing contrast enhanced CT examination of abdomen who were more than 18 years were the participants of the study. The patient's history and well informed consent was taken at the site of examination.

Patients who were pregnant, had a history of valvular heart disease, cardiac or aortic structural disease or arrhythmia, were excluded. Patients with IVC pathologies and variants; and hemodynamically unstable patients were also excluded from the study.

CT scan was performed on 128 slice MDCT scanner (Siemens Somatom Definition As+, TUTH Biomedical equipment no: 1001915) and data collection and measurement were done in Syngo. Via workstation with screen resolution of 3 megapixel.

### Imaging protocol:

| | |
|---|---|
| Patient Position | Supine feet first |
| Scan Orientation | Cranio-caudal |
| Scan Area | from lower chest to symphysis pubis |
| KVp | 120 (with care KV) |
| Mas | 200 |
| Detector Collimation | 0.6 x 128mm |
| Pitch | 0.85 |
| Contrast Injection | 70-100 ml IV at 3 ml/sec |
| Scan Delay | 35-45 sec after bolus tracking |

***Table 1: Imaging protocol of CECT Abdomen***

### Measurement of IVC diameter

We measured the maximal anteroposterior and transverse diameters of the IVC at the level of the renal vein. The caliber of the vessels was measured via a length measuring tool. The transverse diameter (TD) and the anteroposterior diameter (APD) of the IVC were measured at the level just above the renal veins.

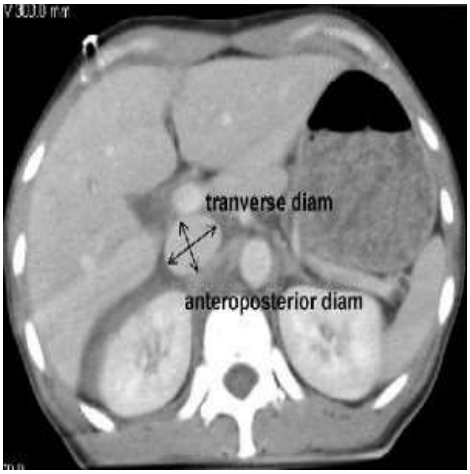


***Figure 1: Method for measuring inferior vena cava (IVC) the maximal transverse and anteroposterior diameters of the IVC were measured using a length-measuring tool***

## STATISTICAL ANALYSIS

The data obtained were tabulated in excel 2016 worksheet and analyzed statistically by using an IBM SPSS 25. Data obtained were analyzed using the descriptive statistics to summarize the measurement of IVC, and inferential statistics (independent samples t-test) to verify if there were significant differences with age and gender. $P<0.05$ was considered to be statistically significant.

## RESULT

A total of 163 patients were enrolled in the study. Among them 77 were male and 86 were female. The mean age of study population was 51.09±9.703. The minimum age of population was 27 years and maximum were 74 years.

| No. of patients | Mean (mm) | Median (mm) | SD (mm) | Range (mm) | Minimum (mm) | Maximum (mm) |
|---|---|---|---|---|---|---|
| 163 | 51.09 | 51.00 | 9.703 | 47 | 27 | 74 |

***Table 2: Descriptive statistics of age in population.***

| Gender | Frequency | Percent |
|---|---|---|
| Female | 86 | 52.8 |
| Male | 77 | 47.2 |
| Total | 163 | 100.0 |

***Table 3: Gender wise distribution of population***

The patients were divided into five groups on the basis of age having class width of 10 from 25 years to 74 years as follow:

| Variables | AP(mm) | | | | T(mm) | | | |
|---|---|---|---|---|---|---|---|---|
| | Mean | SD | Maximum | Minimum | Mean | SD | Maximum | Minimum |
| Male | 14.81 | 2.03 | 18.84 | 12.00 | 26.60 | 2.63 | 35.96 | 20.64 |
| Female | 15.84 | 2.22 | 18.92 | 12.02 | 26.02 | 2.77 | 39.05 | 22 |
| Total | 15.35 | 2.18 | 18.92 | 12.00 | 26.29 | 2.71 | 39.05 | 20.64 |

***Table 4: Frequency distribution of population***

### Distribution of AP and T diameters of IVC to Gender

| Age group | Frequency |
|---|---|
| 25-34 | 7 |
| 35-44 | 32 |
| 45-54 | 67 |
| 55-64 | 42 |
| 65-74 | 15 |
| Total | 163 |

***Table 5: Mean and S.D of AP and T diameters of IVC in normal population. (n=163)***

The mean value of AP diameter was found to be 15.35±2.18mm and the minimum diameter was 12.00 mm and the maximum diameter was found to be 18.92mm in general population. From the study it can be noted that the AP diameter of IVC in female (15.84 mm) is higher than male (14.81mm). [Table-5]. On performing independent sample t test for two means it was observed to be statistically significant ($p<0.05$) [Table 6].

| T | Df | P | Mean Difference | Std. Error Difference | 95% Confidence Interval of the Difference | |
|---|---|---|---|---|---|---|
| | | | | | Lower | Upper |
| -3.098 | 161 | 0.002 | -1.03555 | 0.33422 | -1.69557 | -0.37552 |

***Table 6: Independent sample t test for AP diameter of IVC and gender. (n=163)***

The mean value of T diameter of IVC was found to be 26.29±2.71mm and the minimum diameter was 20.64 mm and the maximum diameter was found to be 39.05 mm in general population. From the study it can be noted that the T diameter of IVC in male is higher than female [Table-5]. On performing independent sample t test for two means it was observed to be statistically not significant ($p>0.05$) [Table 7].

| T | df | P value | Mean Difference | Std. Error Difference | 95% Confidence Interval of the Difference | |
|---|---|---|---|---|---|---|
| | | | | | Lower | Upper |
| 1.367 | 161 | 0.174 | 0.58003 | 0.42430 | -0.25787 | 1.41794 |

***Table 7: Independent sample t test T diameter of IVC and gender.(n=163)***

## Distribution of AP and T diameters of IVC accordance to Age

The variations of AP and T diameters of IVC in different age group of study population are tabulated below and bar graphs are presented alongside.

| Age group | AP(mm) | T(mm) |
|---|---|---|
| 25-34 | 15.07 | 25.26 |
| 35-44 | 15.86 | 25.43 |
| 45-54 | 15.28 | 26.25 |
| 55-64 | 15.39 | 26.34 |
| 65-74 | 14.96 | 27.17 |
| TOTAL | 15.35 | 26.29 |

***Table 8: The variation of AP and T diameters of IVC in different age group.***

## Correlation for AP diameter of IVC with age

| | |
|---|---|
| Correlation coefficient | -0.007 |
| p value | 0.929 |

***Table 9: Correlation for AP diameter of IVC with age***

The Karl Pearson's correlation value -0.007 shows that there is weak negative correlation between age and AP diameter of IVC. The scatter plot diagram below (Fig- 2) summarizes the result:

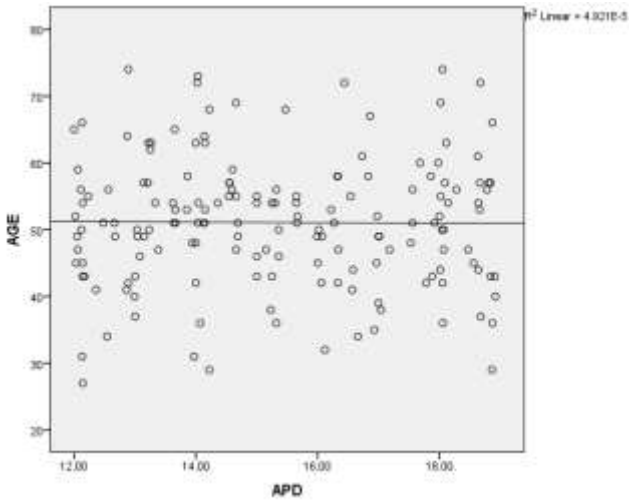


***Figure 2: Distribution of AP diameter of IVC with age***

## Correlation for T diameter of IVC with age

| | |
|---|---|
| Correlation coefficient | 0.149 |
| p value | 0.058 |

***Table 10: Correlation for T diameter of IVC with age***

The Karl Pearson's correlation value 0.149 shows that there is weak positive correlation between age and T diameter of IVC. The scatter plot diagram below (Fig- 3) summarizes the result

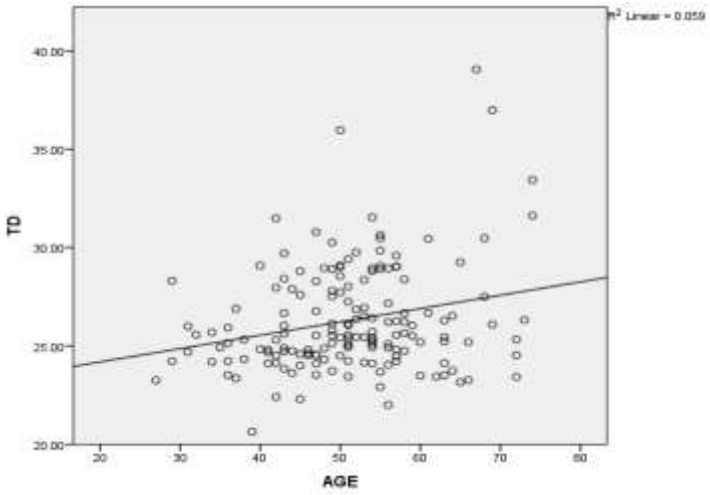


***Figure 3: Distribution of T diameter of IVC with age***

## DISCUSSION

The inferior vena cava (IVC) is the main conduit of venous return to the right atrium from the lower extremities and abdominal viscera. It can be a source of critical information for referring clinicians, and recognition of IVC variants and pathologic characteristics can help guide patient treatment. The purpose of this article is to evaluate, through computerized tomography, the diameters of the Inferior Vena Cava, as well as they, are connected to gender and age. This study was done using CT scan to establish normal diameters for IVC in the Nepalese population and to study the variation in IVC diameter according to age and gender. In order to reduce confusion in terminology, IVC diameters greater than the upper limits of normal, but not meeting criteria for an aneurysm, should be described as dilated. One hundred sixty-three patients were enrolled in the study (77 males and 86 females) with a mean age of 51.09 years (Table 4). The results showed that the normal IVC diameter were correlated with patient age [Table 10]. The AP diameter of IVC between male and female was statistically significant and had a weak negative correlation with age whereas the T diameter was statistically insignificant and had a weak positive correlation with age.

In our study, the mean± standard deviation (SD) of the anteroposterior (AP) diameter of the IVC in men measured was 14.8±2.03 mm and 15.84±2.22 mm in women (Table 5). The mean± standard deviation (SD) of the transverse (TV) diameters, measured were 26.02±2.77mm in women and 26.60±2.63 mm in men. This showed that men had slightly greater T diameter than in women. Similar findings were seen in the study done by Salah Elbagir et al and Emre Gokeen et al. Salah Elbagir et al found mean AP and transverse diameters in male and female as 15.31±1.49 mm, 14.11±1.46 mm; 25.47±1.69 mm and 25.47±1.69 respectively [9,11]. Emre Gökçen et.al found mean diameter of 24 mm in study group and 23 mm in control group. Martin R. Prince et al found smaller caval diameter (20±3 mm). This difference could be due to the smaller sample size and the difference in ethnicity [11,10].

The size of the AP and T diameters of IVC between male and female were statistically significant, however, the size of the transverse diameter of IVC was insignificant [Table-6 and 7]. Salah Elbagir et.al. found statistically significant difference between APD and TD of male and female with male having larger IVC which can be justified by the fact that male also has larger body surface area than female [9].

In our study, the APD of IVC was decreased and TD of IVC was increased with age [fig 2,3]. The size of APD was observed to have weak negative correlation and TD have weak positive correlation with age [Table-9

and 10]. In study conducted by Salah Elbagir et.al. there was linear decrease in size of IVC with increase in age and stated that there is weak negative correlation of diameter of IVC with age [9].

## CONCLUSION

The mean Antero-Posterior diameter of inferior vena cava was 15.35 mm and transverse diameter was 26.29 mm. The size of AP diameter of IVC between male and female was statistically significant but the T diameter was statistically insignificant. The AP diameter of IVC had weak negative correlation with age whereas T diameter of IVC had weak positive correlation with age. The information provided in this study will allow radiologists to detect and accurately characterize IVC abnormalities to guide clinical decision making and improve patient care. Recognition of IVC processes is essential to patient treatment.

### *Declaration by Authors*

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**Conflict of Interest:** The authors declare no conflict of interest.

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