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Evaluation of the Normal Inferior Vena Cava Diameters in Sudanese's by Multidetector Computed Tomography

Salah Elbagir[1,3], Mohamed Yousef[1,2], Ikhlas Abdelaziz[1], Lubna Bushara[4], Hammad Abdoh[5], Mohammed Salih[6]

[1]*College of Medical Radiological Sciences, Sudan University of Science and Technology, Khartoum Sudan*
[2]*Batterjee Medical College, Department of Radiological Science, Jeddah, Saudi Arabia.*
[3]*Al-Ghad International College for Applied Medical Science, Medical Imaging Technology Department, Burida, KSA*
[4]*Hail University, College of Medical Applied Sciences, Department of Diagnostic Radiology Sciences, Hail – KSA.*
5Al-Azhar University, New Damietta Faculty of Medicine Anatomy Department, Damietta, Egypt
[6]*Al-Ghad International College for Applied Medical Science, Medical Imaging Technology Department, Abha, KSA*
Corresponding Author: Dr.Salah Elbagir

Abstract: *Knowledge of the normal Diameters of the Inferior Vena Cava is important regarding the detection of the abnormal and valuable in the treatment of patients with treatment of patients suffering from traumatic shock. The study was undertaken to evaluate, through computerized tomography, the diameters of the Inferior Vena Cava, as well as they, are connected to gender, age, and body surface area. A retrospective cohort study was performed at included 72 patients (41 males and 31 females) with a mean age of 47.2 years consecutive adults free of cardiac or aortic structural disease or arrhythmia who referred for abdominal CT scanning in the radiology department of Royal Care Hospital in Khartoum- Sudan during the period from August 2015 to May 2018. Anteroposterior (AP) and transverse (TV) diameters of the IVC were measured at the level of the renal vein. This study revealed that the mean± standard deviation (SD) of the anteroposterior (AP) diameter of the IVC in men measured was 25.47±1.69 mm, 24.15±1.58 in women. The mean± standard deviation (SD) of the transverse (TV) diameters, measured were 14.11±1.46 mm. in women and 15.3112±1.49919mm in men. It concluded that normal dimensions IVC by CT scan was established and correlated with age and gender, 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, Future studies should focus on multicenter enrollment.*

Keywords *- Evaluation, Inferior Vena Cava Diameters, Sudanese's, Multidetector Computed Tomography*

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I. 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 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 gauge 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. Analysis of these 70 patients' vital signs showed that 70% of them were hemodynamically normal with no clinical evidence of shock, suggesting that a ''flat'' IVC can be seen in patients who are not in shock. These authors suggested that a flat IVC might be an anatomical finding that is not relevant to the overall volume status of the patient [9].To date, studies of IVC on CT scan are inconclusive with regards to the relationship between IVC and volume status. Currently, there is no evidence in the literature to support the use of measuring the IVC diameter on CT Scans to determine fluid resuscitation status. The inferior vena cava (IVC) is an essential but often overlooked structure at abdominal imaging. It is associated with a wide variety of congenital and pathologic processes and can be a source of vital information for referring clinicians. The study was undertaken to evaluate, through computerized tomography, the diameters of the Inferior Vena Cava, as well as they, are connected to gender, age and body surface area..

II. Material and Methods

Subjects

A retrospective review of clinical and MSCT data was conducted among the target population for this study were patients who referred for abdominal CT scanning to radiology department of Royal Care Hospital in Sudan during the period from August 2015 to May 2018.The machine used in this study was Toshiba CT scan machine 64 detectors model Aquilion 64 manufacture date 2009 Siemens CT scan machine Hi-Speed CT/E Dual CT Scanner model SOMATOM definition flash with 256 detector manufacture date 2011). Three options of slice thickness: 3mm, 5mm, and 10mm.Similar scan interspaces A total of 72 patients (41 males and 31 females) with a mean age of 47.2 years consecutive adults free of cardiac or aortic structural disease or arrhythmia who referred for abdominal CT scanning in the radiology department of Royal Care Hospital in Khartoum- Sudan during the period from August 2015 to May 2018. The calculated measurement of the normal optic chiasm on MR sections can be used as a comparative standard by which to detect relatively smaller or larger chiasms, regardless of whether the measurements are in exact ratio to the actual nerve.

CT Imaging Protocol:

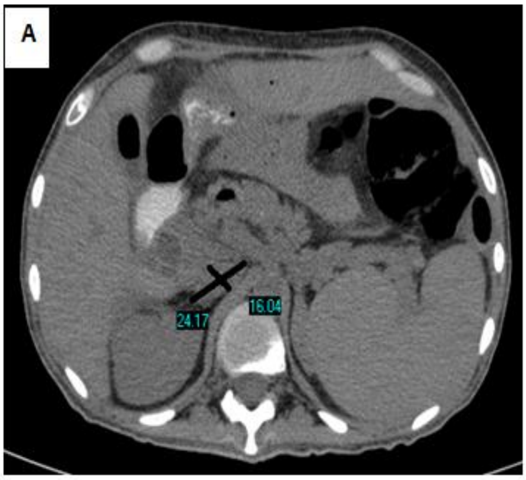
CT scans were performed on multi-channel helical scanners that allowed the retrospective reconstruction of image data into data sets of different spatial quality and image characteristics. CT acquisition parameters were based on a standard protocol, including detector collimation of 0.5-2.5 mm. The technical exposures factors that were used in this study were 120 Kv, 100 mA, 10 mm increments, 3 - 10 mm slice thickness with identical reconstruction index and a rotation time 1.5sec.

Examinations were considered acceptable if all images of the thoracic and abdominal aorta were intact and available with soft tissue window settings.

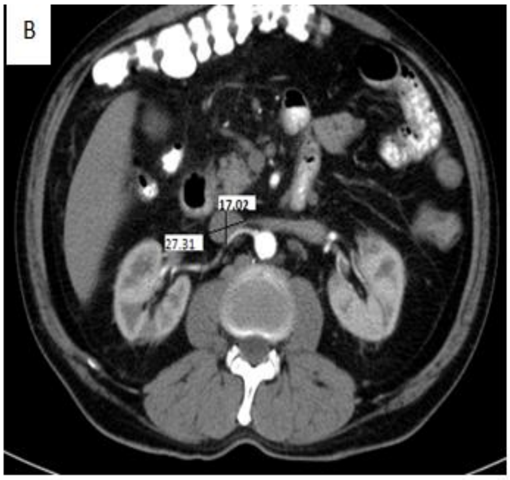
The scan was done started from lower chest to symphysis pubis in the most cases contrast media (Omnipaque -300 ml) to delivered into the body through the venous system by use sure start technique the dose (70-100 ml) according to patient weight, age and hospital polices with delay 30se-40 se, the rate of injection 2 - 3- ml/ s using automatic injector machine. The technical exposures factors that were used in this study were 120 Kv, 100 mA, 10 mm increments, 3 - 10 mm slice thickness with identical reconstruction index and a rotation time 0.75sec.

Measurement

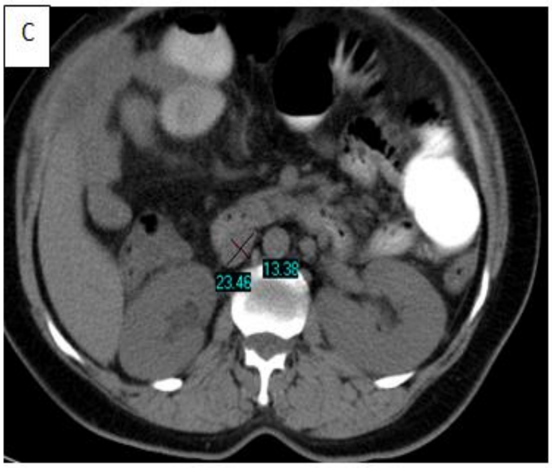
We measured the maximal anteroposterior and transverse diameters of the IVC at the level of the renal vein. The caliber of the vessels was measured via a length measuring tool. The transverse diameter (T) and the anteroposterior diameter (AP) of the IVC were measured at four predetermined abdominal levels: just above the liver edge, just below the intrahepatic IVC, just above the renal veins, and just above the fork of the IVC(Figure 1).



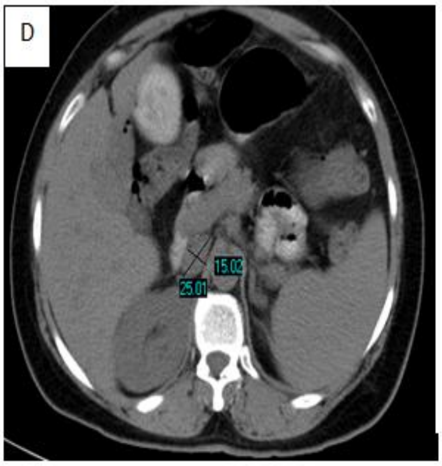
Male 25 years



Male 73 years



Female 40 years



Female 61 years

Figure 1(A-D). 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 were analyzed using Excel program and SPSS version 16 for significances of tests was used. Frequency tables mean and standard deviations were presented.

III. Results

Table (1) showed Minimum, Maximum, Mean, Std. Deviation of Demographics, and Inferior Vena Cava Index

	N	Minimum	Maximum	Mean	Std. Deviation
Age	72	21.0	79.0	47.167	15.5943
Weight	72	46.0	109.0	81.083	12.7994
Height	72	148.0	192.0	172.139	9.9835
Body Mass Index	72	20.90	36.96	27.3150	3.84181
Transverse	72	20.82	28.12	24.9036	1.76065
AP	72	11.38	17.72	14.7939	1.58759

Table (2) showed Correlations of Demographics and Inferior Vena Cava Index

		Age	Weight	Height	Body Mass Index	Transverse	AP
Age	Pearson Correlation	1	.477**	-.178	.710**	-.023	-.189
	Sig. (2-tailed)		.000	.134	.000	.848	.111
	N	72	72	72	72	72	72
Weight	Pearson Correlation	.477**	1	.564**	.689**	.228	.109
	Sig. (2-tailed)	.000		.000	.000	.054	.362
	N	72	72	72	72	72	72
Height	Pearson Correlation	-.178	.564**	1	-.189	.418**	.379**
	Sig. (2-tailed)	.134	.000		.112	.000	.001
	N	72	72	72	72	72	72
Body Mass Index	Pearson Correlation	.710**	.689**	-.189	1	-.060	-.194
	Sig. (2-tailed)	.000	.000	.112		.614	.103
	N	72	72	72	72	72	72
Transverse	Pearson Correlation	-.023	.228	.418**	-.060	1	.694**
	Sig. (2-tailed)	.848	.054	.000	.614		.000
	N	72	72	72	72	72	72
AP	Pearson Correlation	-.189	.109	.379**	-.194	.694**	1
	Sig. (2-tailed)	.111	.362	.001	.103	.000	
	N	72	72	72	72	72	72
**. Correlation is significant at the 0.01 level (2-tailed).							

Table (3) showed Minimum, Maximum, Mean, Std. Deviation of male Demographics, and Inferior Vena Cava Index

	N	Minimum	Maximum	Mean	Std. Deviation
age	41	25.0	68.0	42.439	12.0147
Weight	41	61.0	109.0	82.951	12.6372
Height	41	167.0	192.0	178.585	7.0142
Body Mass Index	41	20.90	29.80	25.8256	2.84733
Transverse	41	22.16	28.12	25.4724	1.69105
AP	41	12.23	17.72	15.3112	1.49919

Table (4) showed Correlations of male Demographics and Inferior Vena Cava Index

		Age	Weight	Height	Body Mass Index	Transverse	Ap
Age	Pearson Correlation	1	.569**	.132	.642**	-.145	-.344*
	Sig. (2-tailed)		.000	.412	.000	.365	.028
	N	41	41	41	41	41	41
Weight	Pearson Correlation	.569**	1	.729**	.844**	.023	.000
	Sig. (2-tailed)	.000		.000	.000	.885	.999
	N	41	41	41	41	41	41
Height	Pearson Correlation	.132	.729**	1	.291	.169	.195
	Sig. (2-tailed)	.412	.000		.065	.292	.223
	N	41	41	41	41	41	41
Body Mass Index	Pearson Correlation	.642**	.844**	.291	1	-.080	-.165
	Sig. (2-tailed)	.000	.000	.065		.619	.304
	N	41	41	41	41	41	41
Transverse	Pearson Correlation	-.145	.023	.169	-.080	1	.628**
	Sig. (2-tailed)	.365	.885	.292	.619		.000
	N	41	41	41	41	41	41
AP	Pearson Correlation	-.344*	.000	.195	-.165	.628**	1
	Sig. (2-tailed)	.028	.999	.223	.304	.000	
	N	41	41	41	41	41	41
**. Correlation is significant at the 0.01 level (2-tailed).							
*. Correlation is significant at the 0.05 level (2-tailed).							

Table (5) showed Minimum, Maximum, Mean, Std. Deviation of female Demographics, and Inferior Vena Cava Index

	N	Minimum	Maximum	Mean	Std. Deviation
Age	31	21.0	79.0	53.419	17.6669
Weight	31	46.0	102.0	78.613	12.7950
Height	31	148.0	174.0	163.613	6.1950
Body Mass Index	31	21.00	36.96	29.2848	4.13278
Body Surface Area	31	1.37	2.09	1.8458	.16641
Transverse	31	20.82	27.31	24.1513	1.58001
AP	31	11.38	17.02	14.1097	1.45560

Table (6) showed Correlations of female Demographics and Inferior Vena Cava Index								
		Age	Weight	Height	Body mass index	Body surface area	Transverse	AP
Age	Pearson Correlation	1	.611**	.149	.671**	.529**	.393*	.192
	Sig. (2-tailed)		.000	.423	.000	.002	.029	.301
	N	31	31	31	31	31	31	31
Weight	Pearson Correlation	.611**	1	.582**	.917**	.965**	.403*	.117
	Sig. (2-tailed)	.000		.001	.000	.000	.025	.532
	N	31	31	31	31	31	31	31
Height	Pearson Correlation	.149	.582**	1	.218	.773**	.314	.098
	Sig. (2-tailed)	.423	.001		.239	.000	.086	.599
	N	31	31	31	31	31	31	31
Body mass index	Pearson Correlation	.671**	.917**	.218	1	.785**	.342	.097
	Sig. (2-tailed)	.000	.000	.239		.000	.059	.603
	N	31	31	31	31	31	31	31
Body surface area	Pearson Correlation	.529**	.965**	.773**	.785**	1	.407*	.122
	Sig. (2-tailed)	.002	.000	.000	.000		.023	.515
	N	31	31	31	31	31	31	31
Transverse	Pearson Correlation	.393*	.403*	.314	.342	.407*	1	.669**
	Sig. (2-tailed)	.029	.025	.086	.059	.023		.000
	N	31	31	31	31	31	31	31
AP	Pearson Correlation	.192	.117	.098	.097	.122	.669**	1
	Sig. (2-tailed)	.301	.532	.599	.603	.515	.000	
	N	31	31	31	31	31	31	31
**. Correlation is significant at the 0.01 level (2-tailed).								

IV. 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, age and body surface area. This study was done using CT scan to establish normal diameters for IVC in the Sudanese population and to study the variation in aortic diameter according to age, gender, and different vertebral levels. 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. 72 patients were enrolled in the study (41 males and 31 females) with a mean age of 47.2 years Table (1). The results showed that the normal IVC diameter Were correlated with patient age, gender, and vertebral levels Table (2).

In this study, The mean± standard deviation (SD) of the anteroposterior (AP) diameter of the IVC in men measured was 25.47±1.69 mm Table (3), 24.15±1.58 in women Table (5) The mean± standard deviation (SD) of the transverse (TV) diameters, measured were 14.11±1.46 mm, in women and 15.3112±1.49919mm in men. There are several limitations to this study. Our study was a retrospective chart review at a single site, and only 72 patients were evaluated in this study. Large-scale retrospective and prospective research studies are needed to verify the practical value of this new method. The IVC is a highly compliant vessel that changes its diameter and cross-sectional area in parallel with changes in blood volume and central venous pressure. Respiratory, intra-thoracic and intra-abdominal pressures may also influence the volume and diameter of the IVC[10–12]. Accuracy in IVC measurement has clinical implications in the diagnosis and management of cardiac disorders because it affects the estimation of right-sided cardiac pressure, which is estimated semi-quantitatively by non-invasive ultrasound imaging[13] . In the future, if more attention is paid to the wealth of information that MSCT provides, earlier diagnosis of hypovolemic shock will be possible and will allow additional time for physicians to apply the necessary treatments to prevent further deterioration of patients with hypovolemic shock.

V. Conclusion

It concluded that normal dimensions IVC by CT scan was established and correlated with age and gender, 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.

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