

# Comparison of Blood Pressure Variation among Patients undergoing CECT Thorax and NCCT Thorax: A Cross-sectional Study

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## ABSTRACT

**Introduction:** Advancements in Computed Tomography (CT) have been continuously updated with the intravenous administration of contrast media, which enhances the visibility of internal organs and structures in CT scans. Contrast media administration often alters blood pressure.

**Aim:** To observe the blood pressure variations among patients undergoing Contrast-enhanced Computed Tomography (CECT) thorax and Non Contrast Computed Tomography (NCCT) thorax.

**Materials and Methods:** A cross-sectional study was conducted at the Department of Radiodiagnosis and Medical Imaging at Yenepoya Medical Hospital, Deralakatte, Mangaluru, Karnataka, India from February 2022 to August 2022. Patients who underwent examinations of NCCT thorax and CECT thorax within the age group of 20-80 years, involving 62 participants (31- CECT, 31- NCCT) were included. Intravascular contrast material was administered to the patient during a CECT thorax scan. One reader

independently recorded the Systolic Blood Pressure (SBP) and Diastolic Blood Pressure (DBP) five minutes before and five minutes after the venous phase in the CECT thorax and five minutes prior to and five minutes after in the NCCT thorax group. A paired t-test was used for the comparison of SBP and DBP within the group.

**Results:** The mean SBP before the scan was 120.7 mmHg {Standard Deviation (SD)=13.6} and after the scan was 130.7±12.1 mmHg. The mean DBP before the scan was 78.9±8.9 mmHg, and after the scan was 84.2±12.0 mmHg, respectively, before and after the injection of contrast. Therefore, a significant difference was found in the mean SBP and DBP before and after the injection of contrast within the CECT thorax group.

**Conclusion:** There was an increase in blood pressure in patients who had undergone CECT thorax in both males and females. Hence, evaluating BP will provide awareness of different risk factors that can be caused due to the administration of contrast media.

**Keywords:** Contrast-enhanced computed tomography, Diastolic blood pressure, Non contrast computed tomography, Systolic blood pressure

## INTRODUCTION

Computerised axial tomography is another name for CT. The CT scanner was developed by a partnership between an inventive engineer, Godfrey Hounsfield, who designed the machine, and a great neuroradiologist, James Ambrose, who established its clinical utility. It is invaluable in establishing the diagnosis and is highly acceptable to patients. The growth of CT is a fascinating story of scientific achievement [1].

Advancements in CT have been continuously updated with the intravenous administration of contrast media [2]. Radiographic contrast media are a group of medical drugs used to improve the visibility of internal organs and structures in CT [3]. The intravenous administration of contrast media often alters blood pressure [4]. Measurements of blood flow, blood pressure, and heart rate made it possible to analyse the time relationship between the haemodynamic changes after the injection of contrast medium [5].

The force applied by the circulating blood on the walls of the blood vessels is defined as blood pressure. The maximum pressure in the main circulation during systole as the heart contracts is known as SBP. The SBP should be 120 mmHg and lies in the 110-140 mmHg range. The minimum pressure reached during diastole, just before the next systole, is known as DBP. The DBP should be 80 mmHg and lies in the 60-80 mmHg range [6].

A mercury sphygmomanometer is considered the gold standard for measuring blood pressure, but the general prohibition on mercury devices has reduced its use in hospitals. Alternative methods, such as automated electronic devices, are now used. The brachial artery is the best place for measurement [7]. Blood pressure can vary according to age and can be affected by factors such as diet,

excessive alcohol consumption, and environmental factors [8]. Age-related variation in blood pressure is based on pathophysiology and includes affecting blood vessel wall thickening and stiffening, as well as decreasing the speed and strength of cardiovascular muscular contraction [9]. It can be observed that the mean SBP and DBP can be higher in males compared to females [10].

The administration of contrast media may lead to kidney dysfunction, especially in patients with pre-existing renal impairment and those with diabetes. It can also cause cardiac-related problems like vasodilation and an increase in coronary blood flow. Understanding various risk factors and checking for them before using contrast agents enables early detection and immediate treatment of adverse reactions [3,11]. With these considerations, the current study aimed at observing the blood pressure variations among patients undergoing CECT thorax and NCCT thorax.

## MATERIALS AND METHODS

This cross-sectional study was conducted in the Department of Radiodiagnosis and Medical Imaging at Yenepoya Medical Hospital, Deralakatte, Mangaluru, Karnataka, India from February 2022 to August 2022. Approval from the Institutional Ethics Committee was obtained (YEC2/947). Written informed consent was obtained from all participants. Based on indications, they were allocated to 31 NCCT thorax and 31 CECT thorax patients (a total of 62 patients) and were imaged with 128-slice CT scanners (Revolution EVO).

**Sample size:** Sample size estimation was performed using G\*power software.

**Inclusion and Exclusion criteria:** Samples based on the age group between 20-80 years were included, and patients with a history of hypertension, contrast allergy, age below 20 years and above

80 years, and patients who were not willing to give consent were excluded from the present study.

## Study Procedure

Data were collected by instructing the patients to lie down on the CT examination table for five minutes before taking BP measurements. A sphygmomanometer was used to measure BP, and measurements were taken by experienced staff. Intravascular contrast material was administered to the patient during a CECT thorax scan. The contrast media used was non ionic low-osmolar water-soluble contrast media (Iohexol injection USP 350 mg and Contrapaque 350 mg) injected at a rate of 2-3 mL/sec for about 60-65 mL. One reader independently recorded the SBP and DBP five minutes prior to and five minutes after the venous phase in the CECT Thorax, and five minutes prior to and five minutes after the NCCT thorax group. To determine the impact of intravenous administration of contrast media on blood pressure variation, mean SBP and DBP from both groups were compared.

## STATISTICAL ANALYSIS

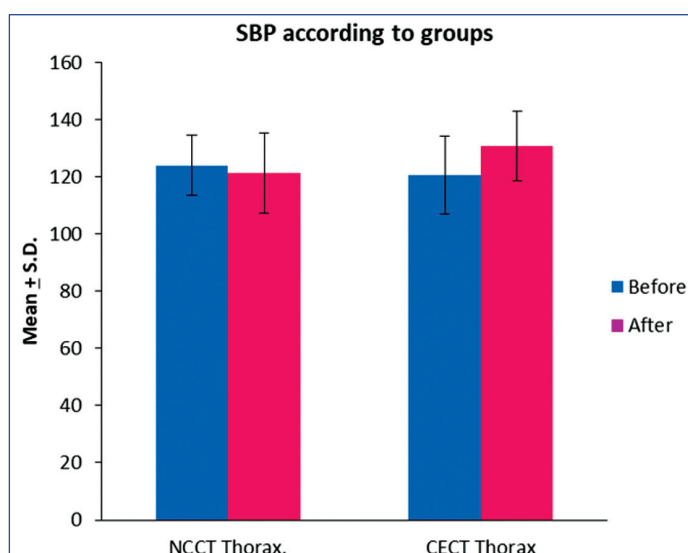
Data analysis was conducted using International Business Machine (IBM) Statistical Package for the Social Sciences (SPSS) version 23.0. A paired t-test was used for the comparison of SBP and DBP within the group.

## RESULTS

The present study consisted of 62 patients who were further divided into two groups, NCCT and CECT thorax, with 31 patients in each group. There were 15 female and 16 male patients in each group. The mean age of the NCCT thorax group was 51.6 years (SD=16.6) and the mean age of the CECT thorax group was 51.9 years (SD=16.2). The mean weight of the NCCT thorax group was 55.7 kg (SD=13.8) and the mean weight of the CECT thorax group was 55.9 kg (SD=13.8). The mean BMI of the NCCT thorax group was 22.3 kg/m<sup>2</sup> (SD=4.3) and the mean BMI of the CECT thorax group was 22.8 kg/m<sup>2</sup> (SD=4.9).

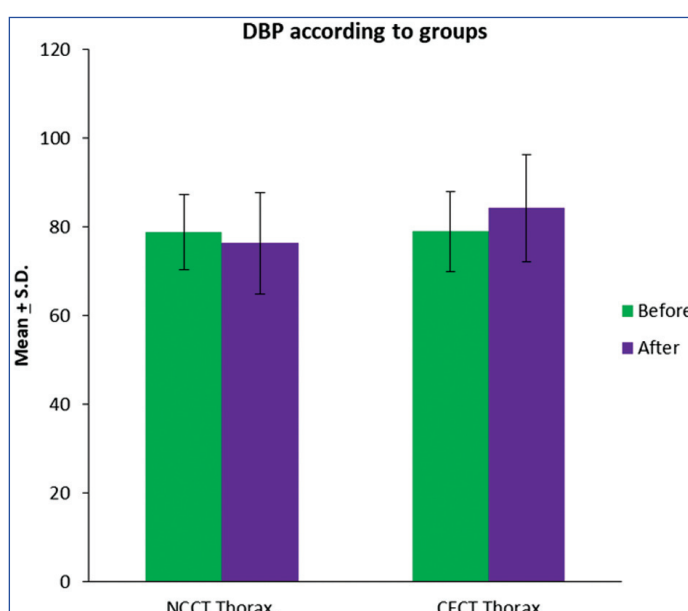
Among the NCCT thorax group, the mean SBP before the scan was 124.0 mmHg (SD=10.5), and the mean SBP after was 121.3 mmHg (SD=14.1). The mean DBP before and after the scan was 78.7 mmHg (SD=8.5) and 76.3 mmHg (SD=11.3), respectively. Among the CECT Thorax group, the mean SBP before and after the scan was 120.7 mmHg (SD=13.6) and 130.7 mmHg (SD=12.1), respectively. The mean DBP before the scan was 78.9 mmHg (SD=8.9), and the mean DBP after the scan was 84.2 mmHg (SD=12.0). Hence, the authors found a significant difference in mean SBP and DBP before and after the injection of contrast within the CECT thorax group. There was no significant difference in mean SBP and DBP before and after the study among the NCCT thorax group [Table/Fig-1,2].

Using the paired t-test, a significant difference in mean SBP and DBP in males and mean SBP in females was observed in patients who underwent a CECT thorax scan. No significant difference in



**[Table/Fig-1]:** Bar chart shows SBP in NCCT thorax and CECT thorax before and after the scan.

The paired t-test was used. There was a difference in mean SBP within CECT thorax group (p-value=0.001) and NCCT thorax group (p-value=0.087) CECT thorax- SBP (<0.001\*)



**[Table/Fig-2]:** Bar chart shows mean DBP before and after NCCT thorax and CECT thorax scan.

The paired t-test was used. There was a difference (p<0.05) in mean DBP within CECT thorax group (p-value=0.001). NCCT thorax group (p-value=0.091)

mean SBP and DBP in the NCCT thorax group in females and males [Table/Fig-3].

## DISCUSSION

High blood pressure is a significant risk factor for various fatal and non fatal cardiovascular and renal events, including myocardial infarction, stroke, atherosclerosis, aortic aneurysm, hypertensive

Variables			Female				Male			
			Mean	SD	"t"	p-value	Mean	SD	"t"	p-value
NCCT Thorax	SBP	Before	122.0	12.1	1.702	0.111	125.9	8.8	0.742	0.469
		After	118.0	16.1			124.4	11.5		
	DBP	Before	80.0	9.3	1.557	0.142	77.5	7.7	0.808	0.432
		After	76.3	12.8			76.3	10.2		
CECT Thorax	SBP	Before	122.0	15.2	-3.287	0.005*	119.4	12.4	-5.506	<0.001*
		After	131.3	14.6			130.0	9.7		
	DBP	Before	78.7	11.3	-1.974	0.068	79.1	6.4	-3.133	0.007*
		After	83.3	15.4			85.0	8.2		

**[Table/Fig-3]:** Comparison of SBP (mmHg) and DBP (mmHg) within the groups for each gender. p-value less than 0.05 indicates statistical significance. (\*Significant)

heart disease, heart failure, peripheral artery disease, and end-stage renal disease [12].

BP is altered in physiological and pathological variations. Physiological factors like sex, body build, diurnal variation, sleep, after exercise, and emotional conditions. Pathological variations include hypertension and hypotension [13].

The present study showed an increase in SBP from  $120.7 \pm 10.5$  to  $130.7 \pm 12.1$  mmHg and DBP from  $78.9 \pm 8.9$  to  $84.2 \pm 12.0$  mmHg, which was associated with intravenous administration of non ionic low-osmolar contrast media in CECT thorax. A study similar to the present was conducted by John AM and Yadav S, showing a similar finding: an increase in both SBP from  $116.64 \pm 6.349$  to  $128.08 \pm 6.489$  mmHg and DBP from  $77.33 \pm 6.351$  to  $87.19 \pm 5.95$  mmHg was observed in CECT abdomen [14].

A study conducted by John AM and Yadav S found that the increased blood pressure in the contrast-enhanced study was induced directly by the contrast media and not solely by the bolus effect [15]. These observations support the findings in the present study that blood pressure in the CECT Thorax study was induced directly by contrast media administration.

Nakano S et al., found hypertensive crises with the injection of non ionic low-osmolar contrast media during CT examination, which supports the findings in the present study of an increase in blood pressure after contrast injection [16].

In a study by Kwon HM et al., in patients undergoing contrast CT scans, they discovered a sudden decrease in blood pressure following the injection of contrast material, determined by measuring the QRS R amplitude from the Electrocardiogram (ECG) data [17]. In the present study, blood pressure was measured using a sphygmomanometer before and after contrast injection in CECT Thorax, and the authors found an increase in blood pressure after contrast injection.

Widmann G et al., conducted a study in which blood pressure and heart rate were measured from 1-3 minutes after the administration of contrast media and normal saline solution. They found that the administration of Iopromide resulted in systemic hypotension [18]. In the present study, the authors used Iohexol contrast media, which showed increased blood pressure after contrast injection, and in the case of NCCT thorax, there was a slight decrease in blood pressure.

Some animal studies reported the effect of non ionic intravenous contrast media administration on blood pressure during CT scans. Harnish PH et al., conducted a study on rabbits in which a variation in blood pressure was observed with contrast media injection and no changes in blood pressure with saline injection [4]. The present study, performed on humans, observed blood pressure variation with contrast media injection and slight variation in NCCT thorax scan.

A study conducted by Morris TW et al., in which contrast media was administered by the hand push method in rabbits, observed a decrease in SBP [19]. This finding does not agree with the present study, in which a pressure injector administered the contrast media. The present study showed an increase in SBP after the injection of contrast media.

A study conducted by Harnish PP et al., on male Wister rats used two types of contrast media, Iohexol, and diatrizoate. They found that blood pressure increased by  $23.2 \pm 2.9$  mmHg in the diatrizoate group and only  $1.8 \pm 3.1$  mmHg in the Iohexol group [20]. In the present study, the authors used only one type of contrast media (non ionic contrast media), Iohexol, which showed a difference in blood pressure (SBP and DBP) before and after the injection of contrast within the CECT thorax.

Kent ST et al., conducted a study using an ambulatory blood pressure monitoring device, which can identify compositions that cannot be measured in the clinic. They found that SBP was  $124 \pm 9$  mmHg in men and  $118 \pm 9$  in females, and DBP was  $75 \pm 9$  mmHg in men and  $73 \pm 9$  mmHg in females [21]. In the present study, the authors used a manual BP apparatus to measure blood pressure. They found changes in SBP were  $127.2 \pm 10.8$  mmHg in men and  $124.7 \pm 16.6$  mmHg in females. DBP was  $80.6 \pm 10.1$  mmHg in males and  $79.8 \pm 14.4$  mmHg in females. Both studies show that blood pressure is higher in males compared to females.

The strength of the present study was that the authors used a manual BP apparatus to check SBP and DBP, as it provides accurate readings compared to the digital BP apparatus, and BP measurement was conducted by one experienced staff nurse. Future studies can be performed to check variations in serum creatinine levels after CECT scans and in angiography cases. Clinically, before using contrast agents, taking a blood pressure reading allows for the early identification and prompt treatment of any adverse reactions that can be caused by contrast agents.

### Limitation(s)

The blood pressure measurement was biased because the interobserver was not present, there were a limited number of samples, and the cause of decreased blood pressure in the NCCT thorax was unknown.

### CONCLUSION(S)

Comparing BP variations before and after the scan in both groups, the authors found an increase in blood pressure in the patients who had undergone CECT Thorax. Understanding various risk factors and checking for them before using contrast agents enables early detection and immediate treatment of adverse reactions. Hence, evaluating BP will provide awareness of the different risk factors that the administration of contrast media can cause.

### REFERENCES

- Petrik V, Apok V, Britton JA, Bell BA, Papadopoulos MC. Godfrey Hounsfield and the dawn of computed tomography. *Neurosurgery*. 2006;58(4):780-87.
- Bae KT. Intravenous contrast medium administration and scan timing at CT: considerations and approaches. *Radiology*. 2010;256(1):32-61.
- Andreucci M, Solomon R, Tasanarong A. Side effects of radiographic contrast media: Pathogenesis, risk factors, and prevention. *BioMed Res Int*. 2014;2014:741018.
- Harnish PH, Mukherji MO, Kido DK. Physiologic effects of contrast media in the rabbit. *Invest Radiol*. 1987;22(11):901-04.
- Delius W, Erikson U. Effect of contrast medium on blood flow and blood pressure in lower extremities. *Am J Roentgenol Radium Ther Nucl Med*. 1969;107(4):869-76.
- Bell D. Blood pressure. Reference article, Radiopaedia.org. (Accessed on 12 Oct 2022). Available from: <https://doi.org/10.53347/rld-69299>.
- Ogedegbe G, Pickering T. Principles and techniques of blood pressure measurement. *Cardiol Clin*. 2010;28(4):571-86.
- Stott DJ, Bowman A. Blood pressure and aging. *J Hum Hypertens*. 2000;14(12):771-72.
- Folkow B. The pathophysiology of hypertension. *Drugs*. 1993;46(Suppl 2):03-07.
- Alhawari HH, Al-Shelleh S, Alhawari HH, Al-Saudi A, Aljbouir Al-Majali D, Al-Faris L, et al. Blood pressure and its association with gender, body mass index, smoking, and family history among university students. *Int J Hypertens*. 2018;2018:4186496.
- Abd TT, Shafique AI, Yasir HS, Seo JH, George RT, Mittal R, et al. Effect of intravenous infusion of iodinated contrast media on the coronary blood flow in dogs. *Int J Cardiol Heart Vasc*. 2016;12:11-14.
- Rahimi K, Emdin CA, MacMahon S. The epidemiology of blood pressure and its worldwide management. *Circ Res*. 2015;116(6):925-36.
- Sebulingam K, Sembulingam P. Arterial blood pressure. Chapter 103. In: *Annals of Internal Medicine. Medical Physiology*. 6<sup>th</sup> edition: Vol-92, India: Jaypee Brothers Medical Publishers (P) Ltd; 1980. Pp. 584.
- John AM, Yadav S. Evaluation of blood pressure variations during the administration of intravascular contrast media in CECT abdomen. *Asian J Pharm Clin Res*. 2018;11(6):309-11.
- John AM, Yadav S. Effect of bolus administration of non-ionic radiopaque contrast media on blood pressure variation. *Radiography (Lond)*. 2019;25(4):346-48.
- Nakano S, Tsushima Y, Taketomi-Takahashi A, Higuchi T, Amanuma M, Oriuchi N, et al. Hypertensive crisis due to contrast-enhanced computed tomography in a patient with malignant pheochromocytoma. *Jpn J Radiol*. 2011;29(6):449-51.

[17]

Kwon HM, Kim SH, Park HS, Park YS, Moon YJ, Kim JM, et al. Augmentation of electrocardiographic QRS R-amplitude precedes radiocontrast-induced hypotension during mobile computed tomography scanning. J Clin Med. 2019;8(4):505.

[18]

Widmann G, Bale R, Ulmer H, Putzer D, Schullian P, Wiedermann FJ, et al. Systemic hypotension following intravenous administration of nonionic contrast medium during computed tomography: Iopromide versus iodixanol. Anesth Analg. 2018;126(3):769-75.

[19]

Morris TW, Prentice L, Ventura J. A comparison of the systemic responses to rapid intravenous injections of ioxilan, iohexol, and diatrizoate in rabbits. Invest Radiol. 1989;24(4):294-97.

[20]

Harnish PP, Mukherji MO, Northington FK, Kido DK. Opiate involvement in contrast media-induced blood pressure changes. Invest Radiol. 1987;22(11):905-07.

[21]

Kent ST, Schwartz JE, Shimbo D, Overton ET, Burkholder GA, Oparil S, et al. Race and sex differences in ambulatory blood pressure measures among HIV+ adults. J Am Soc Hypertens. 2017;11(7):420-427.e3.

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