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# Effect of bolus administration of non-ionic radiopaque contrast media on blood pressure variation

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ABSTRACT

*Introduction:* Haemodynamic changes may occur with the rapid intravenous injection of contrast media due to the osmolality of such pharmaceuticals. This study sought to evaluate the effect of bolus administration of intravenous contrast media on blood pressure variation during the Contrast-Enhanced Computed Tomography (CECT) of the abdomen.
*Methods:* The study included 74 patients who underwent abdominal CECT and they were placed in the first group receiving a maximum of 80 ml of iodinated contrast via pressure injector (4 ml/s). A further 74 patients, who underwent non-contrast enhanced abdominal CT, were placed in the second group in which 80 ml of normal saline was administered via the same manner. Patients with hypertension and who were on anti-hypertensive drugs were excluded from the study. Non-invasive blood pressure was monitored before the injection of contrast media/saline and immediately after the portal venous phase for the CECT scan and after 45 s following the administration of normal saline in the non-contrast CT group. Mean systolic and diastolic blood pressures from both groups were compared to find out the effect of contrast bolus administration on blood pressure variation.
*Results:* Both systolic and diastolic blood pressure increased with the injection of contrast media among CECT scan group. No significant changes in systolic and diastolic blood pressure were found before and after the scan in the non-contrast group.
*Conclusion:* Bolus administration of 80 ml saline has no effect on blood pressure. The increased blood pressure in contrast enhanced studies was induced by the iodinated contrast media and not by the bolus effect.



## Introduction

Intravenous CT contrast media administration has been heavily discussed and has evolved along with the advancements in Computed Tomography (CT) technology.[1] CT scanning together with the rapid administration of contrast media helps in the diagnosis of many conditions. During contrast-enhanced CT (CECT), radiopaque non-ionic contrast media is administered intravenously into the arm and perfuses through the interstitial and intravascular compartments and then reaches the arterial system and subsequently the venous system. The CT opacification of the arterial system depends on several physiologic parameters such as central blood volume, cardiac output, and peripheral vascular pressure.[2] Haemodynamic changes like blood pressure variations in the peripheral and systemic circulation occur when iodinated contrast media is administered intravenously and lasts for a few minutes. Variation in blood pressure changes caused by the administration of non-ionic contrast media has been studied previously. A triphasic pattern in blood pressure changes was observed with blood pressure increasing slightly and then returning to baseline. A negative peak in diastolic blood pressure was noted with intravenous injection of non-ionic contrast media such as Diatrizoate and Iomeprol.[3] While a positive peak in systolic blood pressure was reported with the intra-venous bolus injection of non-ionic contrast media (Omnipaque), in which no significant changes were noted in diastolic blood pressure.[4] Since the contrast is injected as a bolus using a pressure injector this can also affect

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haemodynamics and has not yet been studied. Our study aimed to identify the effect of bolus administration on the blood pressure variation during contrast media injection.

## Materials and methods

A cross-sectional prospective study was approved by the Institutional Research Committee, SOAHS and Ethical Committee, Kasturba Hospital, Manipal. The study recruited subjects who were referred for the CECT of the abdomen with 1) contrast and 2) non-contrast (saline substitute). Administration of both contrast and saline were performed using a Medrad Stellant CT injection system manufactured by Bayer Medical Care. 74 patients who underwent abdominal CECT were placed into the first group in which Iopromide (Ultravist- 300 mgI/ml, Bayer AG) was administered intravenously. The amount of contrast injected was determined based on a commonly used 1:1 linear weight-based iodine dosing (eg: Doubling the iodine mass when patient body weights doubles).[1] Since we selected the patients with body weights between 77 and 80 kg, 80 ml contrast was administered at the rate of 4 ml/s. Another 74 patients (body weights between 77 and 80 kg) who underwent non-contrast abdominal CT were placed into the second group in which in which 80 ml of normal saline was administered via the same manner. Contrast and saline were administered using a radial vein through a three-way cannula sited in the radial fossa. Study participants falling into the category of body weight between 77 and 80 kg were selected due to their availability.

Patients with history of hypertension and who were on anti-hypertensive drugs were excluded. Non-invasive blood pressure was monitored with sphygmomanometer just before the injection and at 45 s after the injection of contrast/saline. Systolic and diastolic blood pressure during pre- and post-bolus administration was measured twice by different people to avoid measurement bias. Calibration of sphygmomanometer used was undertaken once every six months.[5] Mean systolic and diastolic blood pressure for both groups were calculated and reported together with their standard deviations. Data collected during this study was analysed using Repeated measures of ANOVA together with 95% confidence intervals. All statistical analyses were undertaken using SPSS Version 16.0.

## Results

Among the first group, the mean (SD) systolic blood pressure prior to contrast media administration was 116.6 (6.4) mmHg with highest value of 125 mmHg and lowest value of 110 mmHg. The mean (SD) systolic blood pressure after bolus administration of contrast media was 128.1 (6.5) mmHg with a highest value of 135 mmHg and lowest value of 120 mmHg (Table 1). An increase in systolic BP was noted with administration of contrast media. Among the second group, the mean (SD) systolic blood pressure prior to the bolus administration of saline was 119.8 mmHg and this decreased slightly to 118.0 (5.8) mmHg following the saline bolus. A statistically significant increase in blood pressure was noted with the administration of non-ionic radiopaque contrast media among the first group ($P = 0.01$). Even though a decrease in mean systolic blood pressure was noted with bolus administration of saline, it was not clinically or statistically significant. The mean systolic blood pressure variations between two groups are described in Table 1.

The mean (SD) diastolic blood pressure prior to bolus administration of contrast media was 77.3 (6.4) mmHg, where 83 mmHg was the highest diastolic BP noted before injection of contrast media and 70 mmHg was the lowest diastolic BP noted. The mean (SD) diastolic blood pressure increased to 87.2 (6.0) mmHg following the injection of contrast media (Table 2). Among the second (saline) group, the mean (SD) diastolic blood pressure prior to the bolus administration of saline was 80.4 (5.5) mmHg and this decreased to 79.5 (5.5) mmHg following the injection. A statistically significant elevation in diastolic blood pressure was noted with the injection of non-ionic radiopaque contrast media among first group ($P = 0.02$. Both systolic and diastolic mean blood pressure significantly increased after the bolus administration of intra-venous contrast media, this trend was not evident with bolus administration of saline.

## Discussion

The effect of intravenous bolus administration on systemic blood pressure was analysed by monitoring systolic and diastolic blood pressure, before and after, the bolus administration of contrast in one group and saline in another group. These two groups were selected to identify the elevation of systemic blood pressure noted in a previous study and ascertain whether this was due to the presence of contrast media or bolus effect. Among the first group a significant increase in both systolic and diastolic blood pressure were noted with intravenous bolus administration of contrast media. With the bolus administration of saline, a slight decrease in systolic and diastolic blood pressure was noted which was clinically insignificant.

A study conducted by Sachiko et al. in which a hypertensive crisis was reported with the injection of non-ionic low-osmolar contrast media (LOCM) during a CT examination performed 6 days after undergoing high-dose (131) I-MIBG therapy for metastatic pheochromocytoma.[6] In this case they suggested that high-dose (131) IMIBG therapy may be a risk factor for hypertensive crisis after administration of intravenous low osmolar contrast media. The study by Gerlig Widmann et al. reported a significant transient decrease in blood pressure with administration of low-osmolar iopromide in patients being considered for stereotactic RFA of primary and secondary liver tumours.[7] They pointed out the risks of anaesthesia and liver disease in altering the haemodynamic effects of a LOCM injection. Results from our study were undertaken in relatively 'normal' patients not undergoing anaesthesia, so the outcome of both studies cannot be compared. Harnish et al. performed a study on rabbits in which variations in blood pressure were observed with contrast media injection and no changes in blood pressure with saline injection.[8] The author concluded that

**Table 1**
Mean ± SD systolic blood pressure among two groups.

| | Systolic blood pressure (mmHg) |
|---|---|
| **Contrast bolus administration (CECT)** | |
| Before injection | 116.6 ± 6.4 |
| After Injection | 128.1 ± 6.5 |
| **Saline Bolus administration** | |
| Before injection | 119.8 ± 5.2 |
| After Injection | 118.0 ± 5.8 |

**Table 2**
Mean ± SD Diastolic Blood pressure among two groups.

| | Diastolic blood pressure (mmHg) |
|---|---|
| **Contrast bolus administration (CECT)** | |
| Before injection | 77.3± 6.4 |
| After Injection | 87.2 ± 6.0 |
| **Saline Bolus administration** | |
| Before injection | 80.4± 5.5 |
| After Injection | 79.5 ± 5.5 |

systemic blood pressure increases significantly with contrast administration which agrees with our findings. Whereas, a study conducted by Morris et al. in which contrast media was administrated by hand injection in a rabbit observed a decrease in systolic blood pressure.[9] Here the mode of administration of contrast media was different from our study where we used a pressure injector to administer the contrast as bolus and may explain why their results do not agree with our findings. Results from our second group with saline injection shows that effect of bolus administration does not have any impact on blood pressure elevation. These observations support the observation in the current study (group 1), which identifies the contrast administration causes an increase in blood pressure. A decrease in systolic and diastolic blood pressure was noted with bolus administration of normal saline in the second group. A study which supports our finding was conducted by Ukor F Ida et al. in which mean systolic blood pressure shows an average decrease of 1.6 mmHg from the baseline with rapid infusion (bolus administration) of normal saline.[10] Another study conducted by Kavita Morparia et al. stated that no significant changes in blood pressure were reported in response to bolus administration of fluids among the children which again agrees with the findings from our study.[11]

## Conclusion

This study aimed to illustrate the effect of bolus administration of non-ionic intravascular contrast media on blood pressure variation. By analysing the blood pressure variation among two groups we concluded that bolus administration of fluid has no effect on blood pressure. The increased blood pressure in contrast enhanced study was induced directly by the contrast media and not solely by the bolus effect. These findings suggest the requirement of safety measures to be adapted while dealing with the hypertensive patients and those with cardiac compromised undergoing for contrast enhanced studies. A limitation of our study was the absence of blood tests immediately after the contrast injection to rule out the hormone variations. Further research should considered the amount of contrast media based on BMI and including blood investigations to find out the cause of blood pressure elevations.

## Conflict of interest statement

None.

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