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# A study of hemodynamics and complications when radiographic contrast media are used

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**Abstract**
Visualising soft tissues is always challenging in the field of radiology. Majority of times the task is made easy by using radio-opaque contrast media. They are used to improve the contrast of the internal organs that are usually not visualised. Many articles are published regarding the side effects. The side effects are reported to range from a simple itch to life threatening conditions like contrast medium induced nephropathy. Although rare, its effects cannot be neglected. This study is one such attempt to understand the effects of radiographic contrast media on the hemodynamic factors and also to report the most common complications.

**Keywords:** Complications, Hemodynamics, contrast, radiology

## Introduction
Visualising soft tissues is always challenging in the field of radiology. Majority of times the task is made easy by using radio-opaque contrast media. They are used to improve the contrast of the internal organs that are usually not visualised otherwise. Many articles are published regarding the side effects. The side effects are reported to range from a simple itch to life threatening conditions like contrast medium induced nephropathy[1]. Although rare, its effects cannot be neglected.

The currently used contrast media are based on 2,4,6-tri-iodinated benzene ring and are used mainly for diagnostic as well as therapeutic purposes. Iodine-based contrast media are usually classified as ionic or non-ionic and as monomeric and dimeric and are commonly used to visualize vessels, tissues, organs, and the urinary tract. They are helpful in differentiating between normal and pathological areas. They are usually safe but sometimes it can be very harmful and many have reported that it would be more adverse when the patient has already been sensitised for the same drug before.[2] Hypersensitivity reactions, thyroid dysfunction, and contrast-induced nephropathy are the major adverse effects that can be seen in patients undergoing the contrast study. Skin allergy can be acute or delayed and has been reported for upto 48 hours after the procedure.[3-8]

The contrast medium is rich in iodine and sometimes can result in iodine induced hypothyroidism[9,10]. The mechanisms that leads to Contrast Induced Nephrotoxicity (CIN) have not been fully explained and may be due to several factors. The generally held view is that CIN is caused by a combination of a reduction in medullary blood flow leading to hypoxia and direct renal tubular damage due to toxicity of contrast media upon the kidneys. Hypoxia may lead to the formation of reactive oxygen species (ROS) and it has been argued that these in turn are responsible for contrast media toxicity.[9,10,11]. This study is one such attempt to understand the effects of the contrast media on the hemodynamic factors and also to report the most common complications.

## Aims and Objectives
To study the hemodynamics and complications when radiographic contrast media are used in Computed Tomography (CT) and Radiography (X-Rays).

## Materials and Methods
This study was done in the Department of Radiodiagnosis at The Oxford Medical College, Hospital and Research Centre, Bangalore.

The study was done from January 2018 to November 2019.
Four Hundred patients were chosen who underwent the contrast Radiography and the CT.
Radiography (X-Rays) and Computed Tomography scans (CT scans) were done after taking all necessary precautions.
The patients were divided into four groups. The first group which consisted of 100 patients were normal patients. The second which consisted of 100 patients were known hypertensives. The third group which consisted of 100 patients were known diabetics and the fourth group of 100 patients were aged more than 65 years.
The haemodynamics in terms of the heart rate and blood pressure was monitored at five minutes interval for nine consecutive times. The report was noted and the Anova statistics for heart rate, systolic blood pressure and diastolic blood pressure was done.
The complications were noted and descriptive statistics was done.

**Inclusion Criteria**
Only patients undergoing contrast Radiography and CT scan were chosen for the study.

**Exclusion criteria**
- Patients with known nephropathy or on nephrotoxic drugs.
- Patients with high serum creatinine.

## Results

**Table 1:** Heart Rate

| ANOVA for heart rate | | |
|---|---|---|
| | F | Significance(p) |
| intra group difference | 103.029 | <0.001 |
| Inter group difference | 2.775 | 0.001 |

There was a significant intragroup ($p$<0.001) and inter group differences in heart rate during the period of study (p=0.001). Heart rate variations were statistically significant on comparing group D with group A ($p$<0.001), group B (p=0.32) and group C (p=0.11) during the observation period.

**Table 2:** Intergroup difference in heart rate

| Intergroup difference in heart rate | | Significance(p) |
|---|---|---|
| | Group B | .147 |
| Group A | Group C | .300 |
| | Group D | <0.001 |
| | Group C | .983 |
| Group B | Group D | .032 |
| Group C | Group D | .011 |

**Table 3:** Systolic Blood Pressure

| ANOVA for systolic BP | | |
|---|---|---|
| | F | Significance(p) |
| Intra Group difference | 236.83 | <0.001 |
| Inter Group difference | 6.096 | <0_001 |

There was significant difference in the BP in all groups during the period of study ($p$<0.001) with a significant inter group differences ($p$<0.001). The difference was seen between of the groups A and D ($p$<0.001), B and C (**$p$**<0.11), B and D ($p$<0.001), and C and D (p=0.041).

**Table 4:** Inter group difference in systolic BP

| Inter group difference in systolic BP | | Significance(p) |
|---|---|---|
| | Group B | .915 |
| Group A | Group C | .076 |
| | Group D | .<0.001 |
| Group B | Group C | .011 |
| | Group D | <0.001 |
| Group C | Group D | .041 |

**Table 5:** Diastolic Blood Pressure

| ANOVA for diastolic BP | | |
|---|---|---|
| | | Significance (p). |
| Infra group difference | 192.247 | <0.001 |
| Inter group difference | 5.726 | <0.001 |

There is significant intragroup difference ($p$<0.001) and intergroup difference ($p$<0.001) in diastolic BP during period of study. Significant differences exist between group A and group C (p=0.004), group A and group D ($P$<0.001), group B and group D (p=0.048), group B and group 0 ($p$<0.001).

**Table 6:** Inter group difference in diastolic BP

| GROUP | | Significance (p) |
|---|---|---|
| Group A | Group B | .843 |
| | Group C | .004 |
| | Group D | <.001 |
| Group B | Group C | .048 |
| | Group D | <.001 |
| Group C | Group D | .247 |

**Table 7:** Complications

| Complications | Group A | Group B | Group C | Group D |
|---|---|---|---|---|
| Allergic Symptoms | 2 | 1 | Nil | 1 |
| Abnormal Thyroid function | Nil | Nil | 3 | Nil |
| Nephropathy | Nil | 1 | 1 | 1 |

## Discussion
Use of lowest dosage of contrast media must be employed. The development of newer imaging technologies has facilitated faster image acquisition; this has enabled radiologists to perform studies with less intravascular contrast, because the duration of time over which contrast needs to be administered has shortened. Considering that high doses of contrast media are required for percutaneous coronary intervention, several formulas have been suggested to calculate the dosage that is least dangerous for renal function. Cigarroa's formula suggests the following contrast material limit: 5 mL of contrast per kilogram body weight/serum creatinine (mg/dL) with maximum dose acceptable of 300 mL for diagnostic coronary arteriography. Laskey's formula suggests the volume of contrast to calculated creatinine clearance ratio with a cut-off point for the ratio at 3.7 for percutaneous coronary intervention: a ratio >3.7 would be associated, following contrast use, with a decrease in creatinine clearance and a significant increase in mortality of patients with ST elevation myocardial infarction. More recently the cut-off point for Laskey's formula has been placed at 2.0: below a ratio of 2.0 CIN would be a rare complication of percutaneous coronary intervention, but it would increase dramatically at a ratio of 3.0. Some authors have suggested using the ratio of grams of iodine to the calculated creatinine clearance; a ratio 1.42,

or better 1.0, would prevent CIN. But the different results obtained by different authors suggest that this needs to be validated further before being accepted in clinical practice, considering also that patients are not a homogeneous group, since some of them may have complications such as hypotension, shock, and reduced left ventricular systolic function that are themselves risks for CIN.

## Conclusion

Although rare, life threatening complications have been reported with the administration of radio-opaque contrast media for radiological investigations and radiological interventions. Hence adequate precautionary measures have to be taken to ensure the safety of patients undergoing these procedures.

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