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Research Article

Evaluation of Contrast Amount in Patients Undergoing Cardiac Catheterization for Diagnostic and Therapeutic Procedures

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Abstract

Objective: This prospective study was undertaken to determine contrast amount and factors responsible for increasing contrast volume in patients undergoing cardiac diagnostic and therapeutic catheterization.

Background: Due to increase number of cardiac catheterization procedures safety concerns are an issue nowadays. Contrast induced nephropathy, related with contrast amount is a recognized feature after cardiac catheterization. Improved hardware and techniques have resulted in decreased contrast amount use, nevertheless complex procedures still require high doses. Therefore steps should be taken to minimize contrast amount. Hence determination of factors which increase contrast amount will result in better understanding of problem.

Methods: This study was conducted at catheterization Laboratory National institute of cardiovascular diseases, Karachi from June 2014 to June 2015. Patients of both genders and of any age undergoing cardiac catheterization procedures were included in the study. Contrast amount was measured in terms of milliliter (ml). Procedures were grouped into three (consultants, senior registrar and post fellow trainees). Procedures were categorized into 2 groups on basis of accesses sites (femoral and radial). Statistical analysis was performed using SPSS-20.

Results: A total of 824 patients were included in this study out of which 731 were diagnostic coronary angiograms and 94 were PCI. The duration of study was 6 months. Among coronary angiograms 671 (79%) were f-CA and 70 (21%) were r-CA. The mean age was 53.97 ± 10.748 years. Mean contrast volume was 78.55 ± 24.54 (30 - 200) for patients undergoing Invasive Coronary Angiography. Angiography performed by senior registrars, LM disease and those advised CABG required less contrast amount. Out of 226 PCI, 163 were f-PCI and 63 were r-PCI. Mean contrast volume was 147.82 ± 44.8 (50 - 200). Among patients undergoing PCI No significant difference was observed in contrast amount in all groups other than those which required more than one stent.

Conclusion: Mean contrast volume has considerably decreased compared to previous period. Stenting of more than one artery significantly increases contrast volume.

Keywords: *Cardiac Catheterization; Nephropathy; Coronary Angiograms; Angiography*

Introduction

Contrast media is injected during cardiac catheterization procedure. Contrast media is associated with many complications. Some complications are milder and require just symptomatic treatment whereas others are serious. Complications are determined not only by chemical composition of contrast media but amount of media used is also important. Especially in patients with preexisting renal compromise and those at risk for contrast induced nephropathy limiting contrast volume is beneficial.

Contrast induced nephropathy is one of the serious complications cause by use of contrast. CIN complicates about 12.8% of invasive coronary angiography and percutaneous coronary angioplasty [1]. CIN is specially common In patients with preexisting renal disease, diabetes and is related to amount of contrast used [2]. Some types of contrast material are though better to prevent CIN. Non-iodine contrast cause less CIN [3].

Some studies have found gadolinium based contrast superior in patients having preexisting renal disease [4,5].

There is no safe limit of contrast amount for prevention of CIN. Different formulas are proposed to calculate contrast volume to be used.

Various techniques are proposed to reduce contrast volume. Biplane angiography achieves two orthogonal views simultaneously. This result in less image acquisition and hence less amount of contrast use.

Another important step is to avoid confirmatory injection for engagement. Use of modern technology like IVUs can also avoid use of contrast [6].

Some studies have mentioned increased amount of contrast to be associated with CIN [2,7] therefore a study for evaluation of amount of contrast used may be worth to minimize risk of CIN. Purpose of this was to determine predictors which cause increased amount of contrasts. Identification of predictors will highlight importance of strategies to reduce amount of contrast in patient undergoing diagnostic and therapeutic coronary interventions.

Material and Methods

This descriptive cross sectional study was conducted at catheterization Laboratory National institute of cardiovascular diseases, Karachi from June 2014 to June 2015. This study was approved by Hospital ethical committee and informed consent was taken from all patients included in the study. Patients of both genders and of any age undergoing cardiac catheterization procedures were included in the study. Contrast amount was measured in terms of milliliter (ml), from time of onset of fluoroscopy till the end of procedure.

All the Procedures were performed by different operators with different level of expertise and were grouped into three (consultants, senior registrar and post fellow trainees). Procedures were categorized into three groups depending on the nature of procedure (coronary angiography, elective PCI, Primary PCI), and 2 groups on basis of accesses sites (femoral and radial). Statistical analysis was performed using SPSS-20. Normality of distribution of contrast amount was assessed using Shapiro-Wilk test and appropriate Student's t test/ANOVA or Mann-Whitney U/Kruskal-Wallis test was applied to examine the association between contrast volume and patient, procedure, and operator factors. Two sided p-value of ≤ 0.05 will be taken as criteria of statistical significance. Categorical variables are expressed as frequencies and percentages and contrast amount was expressed as Mean ± SD and median (IQR).

Results

Baseline characteristics: A total of 825 patients were included in this study out of which 731 underwent diagnostic coronary angiograms (CA) and 94 underwent percutaneous coronary intervention (PCI). Proportion of male patients was higher, 550 (75.2%) and 184 (81.4%), among both the CA and PCI groups. Table 1 shows baseline characteristics of the study patients.

Clinical and procedural characteristics of patients undergoing CA: Table 2 shows clinical and procedural characteristics and assessment of amount of contrast used during invasive coronary angiography by baseline characteristics of the study sample. There was no significant difference in amount of contrast used during procedures performed via radial and femoral route (p-value = 0.572). Similarly, there was no significant difference between procedures performed in male and female patients (p-value = 0.572). Amount of contrast used during coronary angiographic procedure significantly varies by operator (p-value < 0.001). Procedures performed by post fellows were found to have significantly higher amount of contrast used than the procedures performed by senior registrars or consultants (p-value < 0.001). Patients in whom LV angiogram was done required significantly more contrast amount then those where LV angiogram was not performed (p-value < 0.001). Patients with LM disease required less contrast amount (p-value = 0.003) and patients with normal coronary anatomy required less contrast amount (p-value = 0.024).

	Invasive coronary angiography (CA)	Percutaneous coronary intervention (PCI)
N	731	94
Gender		
Male	550 (75.2%)	74 (78.7%)
Female	181 (24.8%)	20 (21.3%)
Age	53.97 ± 10.75 years	54.92 ± 11.67 years
Up to 50 years	303 (41.5%)	34 (36.1%)
More than 50 years	428 (58.5%)	50 (53.19%)
Accesses site		
Femoral	671 (91.8%)	59 (62.8%)
Radial	60 (8.2%)	35 (37.2%)
Fluoroscopy time		
Mean ± SD	4.18 ± 4.13 minutes	54.92 ± 11.67 minutes
Amount of contrast used		
Mean ± SD	78.56 ± 24.55 ml	147.82 ± 44.84 ml

Table 1: *Baseline characteristics of the study sample.*

	Frequency (%) N=731	Amount of contrast used		
		Mean ± SD	Median (IQR)	P-value
Gender				
Male	550 (75.2%)	78.84 ± 24.46 ml	80 (30) ml	0.409
Female	181 (24.8%)	77.71 ± 24.86 ml	80 (30) ml	
Accesses site				
Femoral	671 (91.8%)	78.35 ± 24.46 ml	80 (30) ml	0.572
Radial	60 (8.2%)	80.83 ± 25.6 ml	80 (25) ml	
Operator				
Consultant	141 (19.3%)	75.53 ± 23.8 ml	70 (20) ml	< 0.001*
Senior registrar	93 (12.7%)	72.63 ± 22.23 ml	70 (20) ml	
Post fellow	497 (68%)	80.52 ± 24.95 ml	80 (20) ml	
LV angiogram				
Yes	444 (60.7%)	80.98 ± 23.36 ml	80 (20) ml	< 0.001*
No	287 (39.3%)	74.81 ± 25.88 ml	70 (20) ml	
Normal Coronary anatomy				
Yes	139 (19%)	73.31 ± 17.04 ml	70 (20) ml	0.024*
No	592 (81%)	79.79 ± 25.86 ml	80 (30) ml	
LM disease				
Yes	54 (7.4%)	70.93 ± 29.73 ml	70 (30) ml	0.003*
No	677 (92.6%)	79.17 ± 24.01 ml	80 (30) ml	
Treatment advised				
CABG	249 (34.1%)	75.44 ± 24.74 ml	70 (20) ml	0.006*
PCI	270 (36.9%)	81.89 ± 24.7 ml	80 (20) ml	
Medical	193 (26.4%)	77.25 ± 22.83 ml	80 (20) ml	
Perfusion scan	19 (2.6%)	85.26 ± 30.98 ml	80 (40) ml	

Table 2: *Assessment of amount of contrast used during invasive coronary angiographic procedures by baseline characteristics of the study sample.*

P-values are based on either Mann-Whitney U or Kruskal-Wallis test.

**Statistically significant at 5% level of significance.*

Clinical and procedural characteristics of patients undergoing PCI: Table 3 shows clinical and procedural characteristics and assessment of amount of contrast used during percutaneous coronary intervention by baseline characteristics of the study sample. Amount of contrast used during percutaneous coronary intervention (PCI) procedures was not significantly different by gender (p-value = 0.550), procedural access site (p-value = 0.269), type of procedure (p-value = 0.787), and stented artery (LAD, RCA, LCX, and OM). While, amount of contrast used was significantly varies by number of stents placed during the procedure (p-value = 0.036).

	Frequency (%) N = 94	Amount of contrast used		
		Mean ± SD	Median (IQR)	P-value
Gender				
Male	74 (78.7%)	149.05 ± 44.63 ml	150 (100) ml	0.55
Female	20 (21.3%)	143.25 ± 46.46 ml	150 (90) ml	
Accesses site				
Femoral	59 (62.8%)	151.95 ± 42.43 ml	150 (90) ml	0.269
Radial	35 (37.2%)	140.86 ± 48.47 ml	150 (100) ml	
Type of procedure				
Elective PCI	79 (84%)	148.29 ± 47.05 ml	150 (100) ml	0.787
Primary PCI	15 (16%)	145.33 ± 31.82 ml	150 (40) ml	
LAD stented				
Yes	63 (67%)	148.57 ± 45.82 ml	150 (100) ml	0.843
No	31 (33%)	146.29 ± 43.47 ml	150 (100) ml	
RCA stented				
Yes	27 (28.7%)	154.44 ± 50.56 ml	170 (100) ml	0.299
No	67 (71.3%)	145.15 ± 42.44 ml	150 (100) ml	
LCX stented				
Yes	14 (14.9%)	156.07 ± 46.91 ml	170 (100) ml	0.485
No	80 (85.1%)	146.38 ± 44.61 ml	150 (100) ml	
OM stented				
Yes	6 (6.4%)	165 ± 39.87 ml	175 (80) ml	0.298
No	88 (93.6%)	146.65 ± 45.12 ml	150 (100) ml	
Number of stents placed				
One	78 (83%)	143.4 ± 41.98 ml	150 (100) ml	0.036*
Two	13 (13.8%)	162.31 ± 56.88 ml	200 (100) ml	
Three	3 (3.2%)	200 ± 0 ml	200 (0) ml	

Table 3: *Assessment of amount of contrast used during percutaneous coronary intervention by baseline characteristics of the study sample.*

P-values are based on either Mann-Whitney U or Kruskal-Wallis test.

**Statistically significant at 5% level of significance*

Discussion

For CA our amount of dye is considerably less than in other studies. Mean contrast volume was 78.55 ± 24.54 (30 - 200) for patients undergoing CA. One study mentioned contrast volume (130 ± 60ML) [8] while another study showed volume use of 96 ± 63 mL [9].

Senior registrar used comparatively less contrast media as compared to consultant and post fellow group. Being middle in tier of experience senior registrars have advantage of both increased frequency of patients and enough experience. This may contribute to lesser amount of contrast used during the CA.

Patients whose arteries were normal required less contrast media. Identification of lesion require multiple images to clearly visualize culprit artery. Hence this may require increased contrast media. In the same way patients who have left main disease also require fewer images. Less images are required because prolong angiography time may result in periprocedural complications. Secondly left main disease patients are often recommended CABG so fewer images are required to visualize surgical target vessel. All result in less contrast amount used during the procedures.

In our study Mean contrast volume was 147.82 ± 44.8 (50 - 200) for patients undergoing PCI.

This was comparatively lower than in previous studies. Previous studies mentioned use of 228 ± 90 ml [1] and 205 ± 90 mL of contrast volume [2]. Number of stent significantly increased contrast amount.

For primary PCI The volume of contrast agent was significantly lower than in most published data (154 mL compared with 158 mL for Bolognese., *et al.* showed that for PPCI amount used was 158 mL [12], while Ando., *et al.* showed contrast volume of 164 ml for their patients [11]. Other studies have showed contrast volume of > 216 ml [12-14].

This difference is mainly due to improvement in both hardware and operator expertise.

Hardware improvement has resulted in better image quality, so that multiple images are not required. In the same way operator expertise due to increase procedure frequency, has resulted in avoidance of non-selective images resulting in less contrast amount.

Our study did not find a difference between radial and femoral route. Other study has similar results [132 (80 - 160) vs 129 (90 - 160)] (p = 0.43) [15].

In a study conducted at same center about five years five years ago showed a significant difference in contrast volume in patients undergoing radial and femoral route coronary angiography [16]. Use of contrast volume was 75.6 ± 27.2 in femoral group while 82.9 ± 28.7 ml in radial group (p value 0.001). While our study did not show such difference. This may be due to the fact that back then radial approach was not undertaken frequently. Only limited numbers of operators were doing radial angiography. While in our study radial approach was used comparatively frequently by all type of operators (consultants, senior registrar, post fellows).

In a study conducted by McCullough., *et al.* [17] results indicate a lower risk for CIN when patients receive < 100 ml contrast media during procedures. Patients who received contrast medium volume < 5 ml/kg/serum creatinine also had minimal chances of developing CIN.

Although Kane., *et al.* [18] demonstrated a significant rise in the incidence of CIN with an increased volume of contrast media. Mekan., *et al.* [19] found that the CIN was not significantly higher with volume of contrast media of > 100 ml. therefore to reach at a conclusive relationship between volume of contrast media and CIN during cardiac intervention procedure further investigations with a larger sample size are required.

Total volume of CM [20] (> 350 mL or > 4 mL/kg) is directly related to the development of CIN. A similar finding has also been proposed by Tziakas., *et al.* [21] who found that ≥ 300 mL of contrast volume was an independent predictors of CIN.

A specific method for quantifying the maximum safe volume of contrast has been proposed by Laskey., *et al*. [22] who demonstrated that a ratio of the volume of contrast media to creatinine clearance (V/CrCl) greater than 3.7:1 correlates strongly with the risk of developing CIN in patients with moderate CKD undergoing CA.

Use of certain hardware may also reduce contrast volume. In order to minimize CM load, novel automated contrast injection devices have been developed which decrease the volume of CM [23] used and which have been shown to reduce the incidence of CIN [24]. But another study comparing automated injectors with manual injectors found no difference in contrast volume [2]. In one study use of 4 Fr catheters for radial approach did reduce amount of contrast (76.25 ± 29.95 Vs 80.00 ± 21.03) [18].

Conclusion

Mean contrast used during procedures has considerably decreased than in the past. Stenting of more than one artery significantly increases contrast volume.

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