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A Comprehensive Review of the Artifact Due to Compression of the Right Ventricle on the Inferior and Lateral Walls of the Heart

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Abstract: Cardiovascular diseases are the most common diseases in the developing and developed countries. Among the existing isotopes, thallium-201 and technetium-99 m are two isotopes commonly used in the heart perfusion scan. In this study, we evaluatedthe heart perfusion scans of patients for possible artifact on the bottom and sidewalls of the heart, related to the compression of the right ventricle. The study was conducted in 2014 at Alzahra Center for Heart Nuclear Medicine. Total 200 patients were selected quite randomly for the study. The selection criteria was the ECO of the patients at arrival and especially their right ventricular pressure. Approximately 20-25 mCi of technetium Mi B was injected intravenously to the patients and the Stress Scan Phase was carried out after an interval of 1-1.5 h after injection. The analysis of the results was conducted in the two sections of descriptive and inferential. Based on the results, there is no significant relationship between gender and septal artifact ($p = 0.982$). According to the results, there were significant relationships between age; ischemia level; diatolic pressure; EF, PAP and septal artifact with the chi-square statistic value of 12.311 ($p = 0.006$), 123.411 ($p<0.0005$), 105.42 ($p<0.0005$), 46.558 ($p<0.0005$), 100.434 ($p<0.0005$). This project aims to reduce the incidence of the false positive results. Detection of the artifact in the septal wall reduces false positives in patients' scans and prevents them from doing excess, aggressive and unnecessary acts of treatment and drug side effects. It also accelerates the timely treatment process and reduces the expenses of patients.

Key words: Patients, diatolic pressure, aggressive, ventricle, EF

INTRODUCTION

Cardiovascular diseases are the most common diseases with which the developing and developed countries are grappling. The American Heart Association 2002 reported the rate of people with cardiovascular disease as 62 million Americans including 32 million women and 30 million men (AHA, 2004). Our country Iran also has not been untouched through this increase and this subject is clearly visible in the epidemiological studies conducted in recent years. For example, Sarraf-Zadegan *et al*. (1999) have done a study to determine the prevalence of coronary artery disease in the population of the city of Esfahan and reported the prevalence of the coronary artery disease as 19.4% in the study population. Among the existing isotopes, thallium-201 and technetium-99 m are two isotopes commonly used in the heart perfusion scan (Fallahi *et al*., 2014; Ghaedian *et al*., 2015). In this study, the technetium-99 m sestamibi is used as the radio-isotope. Technetium-99 m is for using in heart perfusion scans, among which teboroxime, sestamibi, tetrofosmin can be noted (Fallahi *et al*., 2014). In our study, the technetium-99 m composition is used. Of the three compositions mentioned, Teboroxime remains a little time in the heart. Therefore, imaging must be performed immediately after injection. This has resulted in limited use of this composition. Of the two other compositions, sestamibi is most widely used currently. Table 1 reviews the biochemical characteristics of each of the compounds listed. In Table 2, we briefly make a comparison between Thallium-201 with Technetium-99 m (Gerson *et al*., 1997).

Of the disorders which may be caused due to the technical factors in the interpretation of the resulting images are the large or dense breasts in women that can interfere with the interpretation of the defects in heart's anterior and anterior-lateral wall and also the existence of activity under diaphragm which can interfere with the interpretation of the inferior heart wall defects (Zipes *et al*., 2005).

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Table 1: The biochemical charactreristics of each of the compound listed

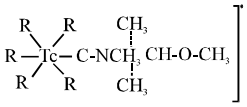
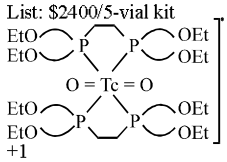
General information	^{201}TI	^{99m}TI-Sestamibi	^{99m}Tc-Tetrofosmin
Generic name	^{201}TI thallous chloride	Technetium ^{99m}Tc-Sestamibi	Technetium ^{99m}Tc-Tetrofosmin
Trade name		Cardiolite	Myoview^{TM}
Other name		MIBI; hexamibi, RP-30	P53
Chemical name	TICI	hexa-2-methoxyisobutylisonitrile	1, 2-bis [bis (2-ethoxyethyl) phosphino] ethane
Classification	Ionic elements	Isonitrile	Diphosphine
Manufacturer	Dupont, Mallinckrodt, Nycomed Amersham	DuPont	Nycomed Amersham
Approval date	Dec. 1977	Dec. 1990	Feb. 1996
Current cost (actual	List: $195/202 mCi	List: $1666/5-vial kit	List: $2400/5-vial kit
Cost may vary greatly)			
Chemical properties			
Structure	T1+ion (thallous)		
Charge	+1	+1	+1
Philicity	Hydrophilic	Lipophilic	Lipophilic

Table 2: Radionuclide properties

Radionuclide properties	^{201}TI	^{99mm}Tc-Sestamibi	^{99mm}Tc-Tetrofosmin
Half-life	73 h	6 h	6 h
Type of decay	Electron capture	Isomeric transition	Isomeric transition
Photon energy and adundance	135 keV γ rays (2.7%)	140 keV γ rays (89%)	140 ke V γ rays (89%)
	167 keV γ rays (10%)		
	68-80 keV x-rays (94%)		
Half value layer	0.25-0.4 mm Pb	0.17 mm Pb	0.17 mm Pb
	3.6-4.8 cm water	4.5 cm water	4.5 cm water

Drug that are labeled in myocardial perfusion imaging by Technetium-99 m like tetrofosmin, sestamibi are released mainly through hepatobiliary system (Wackers *et al*., 1989; Higley *et al*., 1993).

Following this release, the digestive system adjacent to the myocardium which may begin radioactive activity; and this activity can create artifacts in the resulting images (Rehm *et al*., 1996; Karayalcin *et al*., 1998).

MATERIALS AND METHODS

This study was non-interventional and pair comparison. The study was conducted in 2014 at Alzahra Center for Heart Nuclear Medicine. Total 200 patients were selected quite randomly. The selection criteria was the ECO of patients at arrival in the hospitals and especially their right ventricular pressure. The usual method that is done in this center is that about 20-25 mCi of technetium Mi B from Pars Isotope Company belonging to Iran's Atomic Energy Organization is injected intravenously to the subjects and the Stress Scan Phase is carried out after an interval of 1-1.5 h after injection. The analysis of the results was conducted in the two sections of descriptive and inferential. The descriptive section examined characteristics such as mean and standard deviation and descriptive parameters. In the inferential statistics, chi-square test was used due to the nature of the research.

RESULTS

Ejection Fraction (EF) distribution: Regarding the EF abundance, Table 3 and Fig. 1 are presented on the basis of which in the EF index, 24 patients (12%) were between 20 and 40, 78 patients (39%) were between 41 and 50, 85 people (5.42%) were between 51-60 and 13 patients (5.6%) were between 61 and 80.

Table 3: Age distribution in the studied sample

Cumulative percentage	Percentage	Abundance	EF
12	12.0	24	40-20
51	39.0	78	50-41
93.5	42.5	85	60-51
100	6.5	13	80-61
Total	100.0	200	-

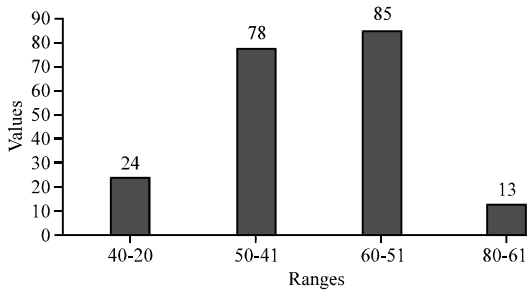


Fig. 1: Age distribution in the studied sample

The relationship between gender and SEPTAL ARTIFACT (imaging error in the septum wall). To evaluate the relationship between gender and septal artifact according to the method and the research literature, the chi-square test was used. Table 4 shows the frequency of the sample based on gender and index septal artifact. Based on the results, there is no significant relationship between gender and septal artifact ($p>0.05$).

Table 4: Contingency table of gender *septal artifact

	Gender		
Catagories	Woman	Man	Total
Septal artifact			
Yes	22	32	54.000
No	58	85	143.000
Total	80	117	197.000
Chi-square	-	-	0.010
The significance level	-	-	0.982

Table 5: Contingency table of age *septal artifact

	Age (years)				
Catagories	40 and lower	41-50	51-60	61 and above	Total
Septal artifact					
Yes	6	9	5	34	54
No	13	36	39	55	143
Total	19	45	44	89	197
Chi-square	-	-	-	-	12.311
The significance level	-	-	-	-	0.0060

Table 6: Contingency table of ischemia level*septal artifact

	Ischemia level				
Catagories	M	N	MO	S	Total
Septal artifact					
Yes	9	1	21	23	54
No	40	94	9	0	143
Total	49	95	30	23	197
Chi-square	-	-	-	-	123.441
The significance level	-	-	-	-	0

Table 7: Contingency table of diastolic pressure*septal artifact

	Diastolic pressure		
Catagories	Yes	No	Total
Septal artifact			
Yes	51	3	54
No	22	121	143
Total	73	124	197
Chi-square	-	-	105.042
The significance level	-	-	0

Table 8: Contingency table of EF*septal artifact

	EF				
Catagories	20-40	41-50	51-60	61-80	Total
Septal artifact					
Yes	20	19	15	0	54
No	4	58	68	13	143
Total	24	77	83	13	197
Chi-square	-	-	-	-	46.558
The significance level	-	-	-	-	0

Table 9: Contingency table of PAP*septal artifact

	PAP				
Catagories	1	2	3	4	Total
Septal artifact					
yes	13	18	14	9	54
no	133	8	1	1	143
Total	146	26	15	10	197
Chi-square					100.434
The significance level					0

The relationship between age and septal artifact. The results concerning the relationship between age and septal artifact are presented in Table 5.

Based on the results, the chi-square statistic value was 12.311 and the significance level was 0.06. Due to this value being <0.05, there is a significant relationship between age and septal artifact. The relationship between ischemia level and septal artifact. The results of the relationship between ischemia level and septal artifact are provided in Table 6.

Based on the results, the chi-square statistic value was 123.411 and the significance level was 0.000. Due to this value being <0.05, there is a significant relationship between ischemia level and septal artifact. The relationship between diastolic pressure and septal artifact. The results of the relationship between diastolic pressure and septal artifact are presented in Table 7.

Based on the results, the chi-square statistic value was 105.42 and the significance level was 0.000. Due to this value being <0.05, there is a significant relationship between diatolic pressureand septal artifact. The relationship between EF and septal artifact. The results of the relationship between EF and septal artifact are presented in Table 8.

Based on the results, the chi-square statistic value was 46.558 and the significance level was 0.000. Due to this value being <0.05, there is a significant relationship between EF and septal artifact. The relationship between PAP and septal artifact. The results of the relationship between PAP and septal artifact are presented in Table 9.

Based on the results, the chi-square statistic value was 100.434 and the significance level was 0.000. Due to this value being <0.05, there is a significant relationship between PAP and septal artifact.

DISCUSSION

Despite advances in prevention of the first and second level cardiovascular disease, nearly 5.6 million Americans per year suffer from pectoral anginaand more than a million people a year are affected by myocardial infarction (Kasper *et al*., 2005). Factors causing artifacts in heart scanned image:

- Breast soft tissue attenuation: causes a defect in the anterior wall
- Obesity is usually associated with a defect in the lateral wall
- The diaphragm in men causes a defect in the lower wall
- Inner lining activity: due to this problem, the reconstruction of SPECT in areas with internal activity leads to accumulation in the created images which can be misinterpreted as an outlet

- Hot spots associated with thickening of the heart muscle can be seen near the papillary, anterior, posterior muscles
- The apical types may be read sometimes as a defect in the lateral wall and sometimes as a defect in the septal wall (septum)
- The non-coronary disease: results from asymmetric relaxation of the septum and thereby change during diastole
- Creep upwards: during exercise, the anterior wall of the heart is displaced against the diaphragm and bending upward and into the chest results in reversible impairment in the inferior wall of the septum
- Diagonal axis and errors in the reconstruction of the aperture around the axis other than the longitudinal axis of the heart: may lead to artifacts in the base areas and this may occur in the presence of apical infarction with an apical dissection. Incorrect adjustment of stress images and redistribution may lead to errors (DePuey and Garcia, 1989; Manglos *et al*., 1993; Friedman *et al*., 1989; Germano *et al*., 1993; Kiat *et al*., 1992; Cooper *et al*., 1992; Parker, 1993)

Occasionally, some incidental activities in radionuclide scintigraphy could be problematic (Eftekhari *et al*., 2010; Haghighatafshar and Khajehrahimi, 2015). Due to the structure of intervention, myocardial perfusion imaging needs high accuracy and sensitivity, so the diagnosis of the artifacts in these images and reduction of the number of false positives requires a high experience and diagnostic accuracy from the nuclear medicine physician to report on these artifacts. In this study, the high prevalence of heart septal artifact in patients with diastolic cardiac failure associated with increased pressure in the right ventricle was studied. This study showed that in patients who have RV strain and their RV strain is confirmed in Echo, the prevalence of septal wall artifact is high and the septal artifacts resulting from scanning in patients with symptoms of increased right ventricular pressure is about 10 times as people who do not have this problem. According to the studies, about 95% of nuclear medicine specialists face errors and confusion in their diagnosis and reporting.

This project aims to reduce the incidence of false positive and to show that for the physician who reports, there is possibility that he reports a false positive and in the end, to show that the detection of this artifact in the septal wall reduces false positives in these patient's can's and prevents them from doing excess, aggressive and unnecessary acts of treatment and the drug side effects. It also accelerates the timely treatment process and reduces the expenses of patients and so on. Such as previous study (Haghighatafshar and Khajehrahimi, 2015) that indicated the importance of fused Single-Photon Emission Computed Tomography (SPECT)/Computed Tomography (CT) images, SPECT/CT imaging may minimize such artifacts.

CONCLUSION

This project aims to reduce the incidence of the false positive results. Detection of the artifact in the septal wall reduces false positives in patients' scans and prevents them from doing excess, aggressive and unnecessary acts of treatment and drug side effects. It also accelerates the timely treatment process and reduces the expenses of patients.

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