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RESEARCH ARTICLE

Effect of age on cardiac output after coronary angioplasty in patients of acute myocardial infarction

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ABSTRACT

Background: Although most of the acute coronary syndrome (ACS) patients are elderly, less data available on the effect of age on outcome after percutaneous coronary interventions (PCI) and major adverse cardiovascular events. In this study, we evaluated the effect of age on clinical outcomes in patients with ACS undergoing PCI because it is a well-known fact that the ages of patients influence clinical outcomes in ACS. **Aims and Objectives:** The aim of the study was to find out the effect of age on outcome of angioplasty in acute myocardial infarction (AMI) patients. **Materials and Methods:** It is a cross-sectional, self-control, interventional study. In this study, cardiac output (CO) of 52 patients of AMI was measured by echocardiography before and after angioplasty. CO is calculated with the help of end diastolic volume, end systolic volume, and left ventricular outflow tract diameter. Statistical software IBM SPSS version 16 was used for analysis of data. **Results:** A negative and statistically significant coefficient of correlation ($r = -0.384$ and $P = 0.005$) was found between age of patients and the value of CO after coronary angioplasty. Linear regression analysis was also done taking CO after coronary angioplasty as dependent variable and age of the patient as the independent variable. It can be hypothesized that as the age advances, CO after angioplasty deteriorates. **Conclusion:** Advancing age is associated with deterioration in outcome after coronary angioplasty in AMI patients.

KEY WORDS: Acute Myocardial Infarction; Age; Cardiac Output

INTRODUCTION

In present days, the elderly population is having a longer lifespan; however, Saunderson *et al.* noticed that the prevalence of cardiovascular diseases is increasing as the age advances.[1] Some authors found that the cardiac output decreases with age. However, some authors noticed that the cardiac output does not always change with ages. Cardiac function can be assessed with the help of resting cardiac output.

Critically ill patients with cardiac pathology cannot be easily assessed for hemodynamic parameters so different methods are used for the assessment of various hemodynamic parameters. However, these invasive and non-invasive methods have their advantages and disadvantages.

Starr *et al.* investigate cardiac output in older "normal" adults using the indirect gas methods. They found that the average cardiac index start declining after 20 years of age and there was a significant decrease in cardiac index after 50 years of age.[2]

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Stead *et al.*, Coutrnanid *et al.*, and Nickerson *et al.* compared for age and cardiac output, using the Fick principle. Stead *et al.* and Coutrnanid *et al.* found that as the age advances cardiac output decreases;[3,4] however, Nickerson *et al.* found that there was no significant change in cardiac output with age.[5]

Smith *et al.* compared mean cardiac index of 10 subjects aged 62–77 years with other 10 subjects aged 22–55 years with the help of indicator dilution technique. They found that mean cardiac index in the age group of 62–77 years is lower (2.67 lts/min) than the subjects of the age group of 22–55 years (3.5 lts/min).[6] With the advancement of modern techniques such as percutaneous coronary intervention (PCI), antiplatelet therapy, statins, beta-blockers, and angiotensin-converting enzyme (ACE) inhibitors, the management of acute coronary syndrome (ACS) is improving day by day.[7,8]

However, it is found that in elderly population prognosis of ACS is poor despite the improvement in management. This is because life-threatening comorbidities are very common in elderly. Many studies showed that in comparison to the younger population, elderly with ACS, who received a conservative treatment, have a higher mortality rate.[9-11] Some studies showed that 1/3rd of elderly patients with ACS landed in heart failure while about 40% showed left ventricular dysfunction.[12-14] Few researchers noticed that in elderly patients, the occurrence of left ventricular systolic dysfunction after ACS is greatly increased.[15,16]

Recently, many studies compared the mortality rate after ACS in between those patients who have decreased left ventricular ejection fraction (LVEF) and those who have normal LVEF. They found higher mortality rate in those patients who have lower LVEF.[13,17-19] Some studies compared conservative treatment in the elderly patients with invasive PCI and they found that those patients who have undergone PCI showed less major adverse cardiac events and reduced mortality rate in comparison to those patients who received conservative treatment.[20,21] Hence, it can be concluded that an invasive approach might be more beneficial for elderly patients with ACS.

In our study, we found that advancing age is associated with deterioration in outcome after coronary angioplasty in acute myocardial infarction (AMI) patients.

MATERIALS AND METHODS

This study was a cross-sectional, self-control, interventional study. The study was undertaken in 52 patients of AMI. All patients were male. Patients were admitted and their ejection fraction, end diastolic volume, end systolic volume, and left ventricular outflow tract diameter determined stroke volume (SV) by echocardiography (ECHO) method. The cardiac output (CO) has been obtained by multiplying SV by heart rate. Coronary angiography was done on all patients. Then patients underwent coronary angioplasty (PCI). After which CO was measured on day 7th of PCI. The CO obtained before and after PCI was analyzed. Patients were divided into eight groups according to their age: Group I (0–10 years), Group II (11–20 years), Group III (21–30 years), Group IV (31–40 years), Group V (41–50 years), Group VI (51–60 years), Group VII (61–70 years), and Group VIII (71–80 years). Exclusion criteria were: Patients having cardiac conditions which affect SV such as anemia, valvular heart disease, myocarditis, cardiac tamponade, cardiac metabolic derangements, and endocrinal disorders such as thyroid dysfunction, arteriovenous fistula (shunt), and vitamin deficiency such as Vitamin B_1 deficiency and pericardial effusion.

Statistical software SPSS version 16 was used for analysis of data. $P < 0.05$ was considered to be statistically significant.

RESULTS

A total of 52 subjects were enrolled, and data from all the 52 patients were used for analysis. 24–80 years male patients were included in this study [Table 1]. The measurements of cardiac outputs of patients were done by ECHO within 6–8 h of diagnosis of acute MI and on the 7th day after coronary angioplasty. Figure 1 shows that patients of age ≤40 years show more improvement in CO after intervention in comparison to the patients of age >40 years. The diagram also shows that the mean Pre-CO is more in age group >50 years in comparison to the patients of age group ≤50 years. It can also be noticed that the mean post-CO consistently decreases after the age of 30 years as the age advances. Figure 1 shows that as the age advances CO after intervention decreases and this is noticed consistently after the age of 40 years. Karl-Pearson coefficient of correlation was determined between Age and Pre-CO and post-CO to measure the strength of the linear relationship. Moreover, further, it was tested for its statistical significance [Figure 2]. The correlation was found significant between age and post-CO ($r = -0.384$ and

Table 1: BMI category of patients

Age group category	Age group (years)	Frequency
I	0–10	00
II	11–20	00
III	21–30	01
IV	31–40	02
V	41–50	12
VI	51–60	11
VII	61–70	23
VIII	71–80	03
Total		52

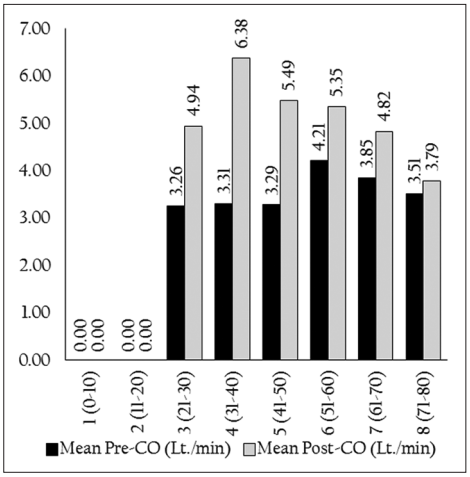

Figure 1: Bar diagram showing relationship between pre-CO, post-CO, and age

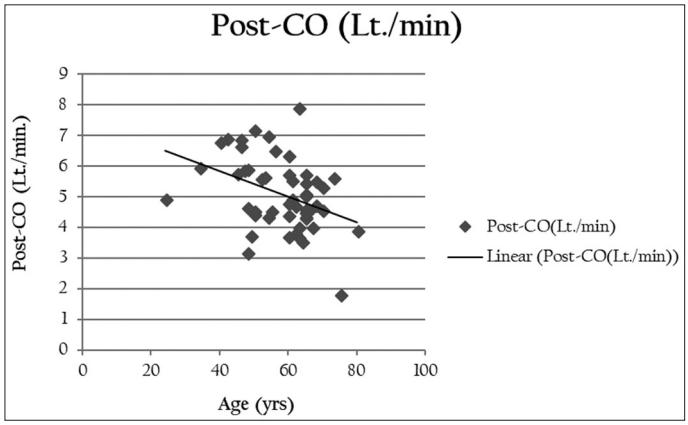

Figure 2: Scatter diagram showing relationship between post-CO and age

P = 0.005) [Table 2]. The negative correlation shows that the patient with higher age will have lower post-CO value. This shows that the patients having higher age will show less improvement in CO after angioplasty.

DISCUSSION

Cardiac output is one of the most important parameters to assess the function of the heart. It is a well-known fact that cardiac output is directly proportional to the heart rate and SV. Hence, in those conditions which increase heart rate due to excitation of the heart such as exercise, stress, and some drugs leads to increase in cardiac output. Likewise, decrease in the heart rate during rest, sleep and some drugs result in a decreased cardiac output. However, in those conditions where heart rate is excessively increased, the ventricles may not have sufficient time to fill properly with blood which results in the decreased cardiac output.

Cardiac output also depends on SV, so the factors which affect SV may alter the cardiac output. Some important factors which can alter SV are a force of contraction, pre-load

Table 2: Correlation and statistical significance between age and pre- and post-CO

Correlations	Post-CO	Pre-CO	Age
Post-CO			
Pearson Correlation	1	0.109	–0.384**
Sig. (2-tailed)		0.440	0.005
N	52	52	52
Pre-CO			
Pearson correlation	0.109	1	0.171
Sig. (2-tailed)	0.440		0.225
N	52	52	52
Age			
Pearson correlation	-0.384**	0.171	1
Sig. (2-tailed)	0.005	0.225	
N	52	52	52

**Correlation is significant at the 0.01 level (2-tailed)

such as volume of blood present in heart's chambers and after-load like resistance of arterial system. Severe blood loss, cardiomyopathies, and failure of cardiac valves may decrease the effectiveness of heart's pump.

During the sympathetic discharge, catecholamines are released which leads to increase in the heart rate as well as increased SV. Hence, in such condition, the cardiac output is very much increased. Those drugs and chemicals which decrease heart rate or those poisons which reduce the heart's ability to contract lead to decreased cardiac output.

Boothby *et al.* showed that as the age advances, the basal metabolism decreases which lead to decrease in cardiac output as well.[22] Before the development of cardiac catheterization, exact measurement of cardiac output was not possible. Hence, with the advancement of cardiac catheterization, it is easy to get reliable data.

Before the development of indicator dilution method and ECHO, measurement of cardiac output was done with the help of calculations based on some formulas and also indirectly with the help of measuring blood pressure, pulse, etc. Indirect methods do not provide a reliable value of cardiac output. Hence, the indicator dilution method and ECHO are now reliable methods to measure cardiac output.

It was found that the cardiac output is an age-dependent parameter and there is a decrement of 1% per year. Granath *et al.* compared the resting cardiac output in old healthy persons (61–83 years) with young persons (average 23 years). He found that cardiac output in elderly was less by 25% in comparison to young persons.[23] Watanabe *et al.* also found that as the age advances the cardiac output declines.[24] However, Jegier *et al.*, Foster and Reeves, Julius *et al.*, and Hanson *et al.* found that age has minimal effect on the cardiac output.[25-28]

The results of present study revealed a linear relationship between age group categories and CO after PCI in AMI patients. The patients of age ≤40 years show more improvement in CO after intervention in comparison to the patients of age >40 years. Although it was an established fact that increasing age has adverse effect on cardiovascular physiology, mean Pre-CO is more in age group >50 years in comparison to the patients of age group ≤50 years.

CONCLUSION

The present study demonstrated that patients of age >40 years show less improvement after coronary angioplasty. Our findings showed the association between age and prognosis in AMI patients and indicated the need for a better understanding of the role of age in such patients.

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