Journal of Chemical Health Risks
www.jchr.org
JCHR (2024) 14(3), 1875-1881 | ISSN:2251-6727

Correlation of Myocarial Oxygen Consumption Index with Hand Grip Strength and Sit to Stand in Coronary Artery Disease Patients Undergoing Angioplasty

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(Received: 04 February 2024 Revised: 11 March 2024 Accepted: 08 April 2024)

KEYWORDS
Handgrip strength (HGS), Coronary Artery disease, Angioplasty, Myocardial Oxygen consumption (MVO2)

ABSTRACT:

Introduction: The condition known as coronary artery disease (CAD) occurs when plaque deposits cause the arteries that carry blood to the heart to narrow or become clogged. PTCA is used to clear blocked coronary arteries and bring blood back to the heart muscle. It is crucial to understand how MVO2 correlates with hand grip strength and the sit-to-stand test inpatients with CAD who have had angioplasty to improve patient outcomes.

Objectives: To find the correlation of MVO2 with HGS and Sit to stand test in CAD patients undergoing angioplasty.

Methodology: 50 subjects diagnosed with CAD were included in the study. MVO2, HGS, and STS were assessed pre and post angioplasty. MVO2 index was assessed using RPP, HGS was assessed by handheld dynamometer, and lower limb strength was assessed by using 1 min STS. Data was analyzed by the software python version 3.9.

Result: There was no statistically significant correlation of MVO2 with HGS and STS pre and post angioplasty.

Conclusion: From this study, we can conclude that there is a weak positive correlation of pre and post MVO2 with pre-post HGS and STS which is not statistically significant. After the comparison of pre and post data of MVO2, HGS, and STS; we can conclude that there was an increase in strength and physical capacity of the subjects but it was not statistically significant.

Introduction:

According to WHO, cardiovascular diseases are the main cause of death worldwide, claiming an estimated 17.9 million lives annually. India has far higher death rate than the rest of the world, with an average of 272 fatalities per 100,000 people[1,2]. Coronary heart disease (CHD), cerebrovascular disease (CVA), peripheral artery disease (PAD), and aortic atherosclerosis are the four basic groups that make up cardiovascular illness[1].

The condition known as coronary artery disease (CAD) occurs when plaque deposits cause the arteries that carry blood to the heart to narrow or become clogged. Plaque, which composed of cholesterol, fat, and other chemicals, can build up over time and reduce the amount of blood that gets to the heart. This may cause a variety of symptoms, such as fatigue,shortness of breath, and chest pain, as well as a heart attack or other severe problems[3]. According to the studies, the prevalence of CHD has increased in India over the past 60

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www.jchr.org
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years,going from 1% to 9-10% in urban areas and from 1% to 6% in rural areas[4].

As plaque builds up in the arteries supplying blood to the heart, coronary artery disease progresses over time. Atherosclerosis is the term for this process. Plaque can slowly accumulate, narrowing the arteries and reducing the amount of blood that can reach the heart. When a piece of plaque breaks off, it can sometimes lead to a blood clot that can totally block the artery and trigger a heart attack[3,5].

The chance of getting coronary artery disease can be raised by a variety of circumstances. Age is significant component because it raises a person's risk of developing CAD. Family history is crucial since genetics may contribute to the emergence of the illness. Smoking, hypertension, elevated cholesterol, diabetes, obesity, and a sedentary lifestyle are the other risk factors. People can lower their chance of developing CAD by being aware of these risk factors.[5].

A catheter-based treatment called percutaneous transluminal coronary angioplasty (PTCA) is used to clear blocked coronary arteries and bring blood back to the heart muscle. Patients with coronary artery disease (CAD) can benefit from this proven and efficient therapy[6].

Handgrip strength has come into focus as a possible sign of general health and functional capacity in CAD patients. It is crucial to comprehend how hand grip strength relates to CAD since doing so can assist individuals who are more likely to have negative outcomes like hospitalization or death[7].

Handgrip strength has been demonstrated to be a predictor of cardiovascular events, including heart attack and stroke, in CAD patients[8]. Low hand grip strength may also be linked to other health issues including frailty and muscular atrophy[9].

Strong hand grips are significantly correlated with CAD, according to several research. For instance, a large-scale investigation including more than 140,000 participants discovered that a lower hand grip strength was linked to a higher risk of CAD and other cardiovascular conditions[10]. In comparison to more conventional risk variables like age and comorbidities, other studies have revealed that hand grip strength may be a stronger predictor of unfavorable outcomes in CAD patients. These results demonstrate the clinical applicability of assessing hand grip strength in CAD patients[11]

The term MVO_2 describes how much oxygen the heart muscle consumes when contracting. The quantity of oxygen-rich blood that may reach the heart is decreased in CAD due to the narrowing or blocking of the blood arteries that supply the heart muscle. MVO_2 rises because of the heart muscle working harder to make up for the shortage of oxygen[12].

The diagnosis of CAD depends heavily on MVO_2. Healthcare professionals can estimate the disease's severity and the likelihood of consequences like a heart attack or stroke by monitoring MVO_2 levels. MVO_2 testing is frequently used with additional diagnostic techniques like angiography or stress tests. Effective CAD therapy and better patient outcomes depend on early diagnosis. Healthcare professionals can recognize CAD in its early stages and create a unique treatment strategy for each patient by using MVO_2 testing[13].

The oxygen demand of the heart muscle is measured by the rate pressure product, or RPP. It is derived by systolic blood pressure multiplied by heart rate. To calculate MVO_2, one may utilize RPP, which indicates the effort done by the heart during exercise. Using RPP to quantify MVO_2 offers a quick and effective way to evaluate cardiovascular health. Since RPP takes both heart rate and blood pressure into account, it offers a more complete picture of cardiac function when estimating MVO_2.[14]

According to research, monitoring MVO_2 via rate pressure product correlates well with invasive techniques and is incredibly accurate. RPP is more sensitive than conventional approaches at spotting early heart disease symptoms, according to several research[14].

The sit-to-stand test is an easy approach to measure the physical function and strength of the lower extremities. It entails keeping track of how long it takes someone to repeatedly get up from a chair and seat back down. Performance on the sit-to-stand test and MVO_2 and hand grip strength may be related in coronary artery disease patients who have had angioplasty[15].

In conclusion, it is crucial to understand how MVO_2 correlates with hand grip strength and the sit-to-stand test in patients with CAD who have had angioplasty to improve patient outcomes. Healthcare professionals can better comprehend a patient's physical function and adjust their treatment strategy by including these indicators in patient evaluations.

Methodology

The observational study was conducted in cardiac ward of Himalayan Institute Hospital Trust, Jolly Grant, Dehradun. Total 52 subjects were screened, out of which 50 subjects were included in the study based on inclusion and exclusion criteria. The inclusion criteria included both the genders aged between 40 – 75 years which were undergoing angioplasty. Subjects who were hemodynamically unstable, who do not comprehend command, had uncompensated heart failure, any deformity of upper or lower limb and had any

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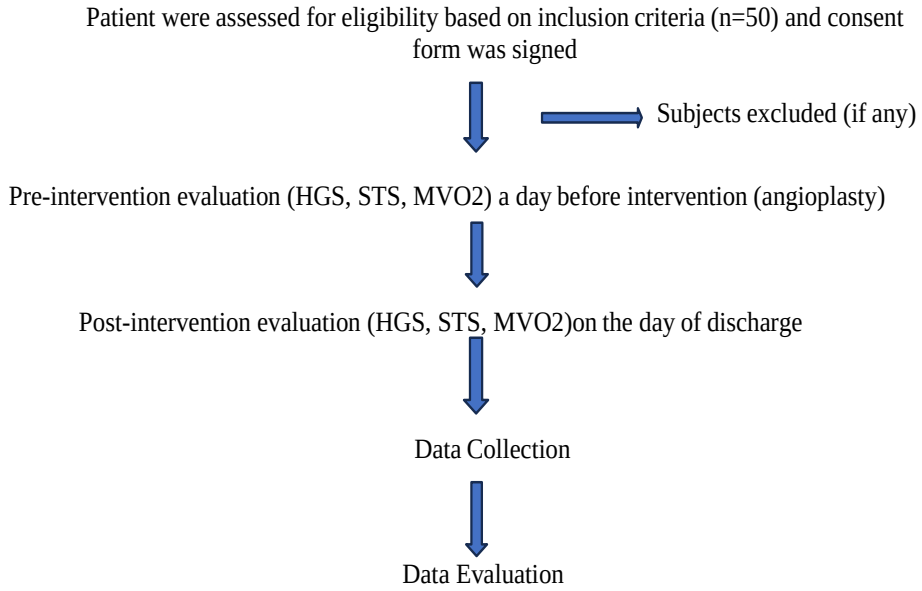
JCHR (2024) 14(3), 1875-1881 | ISSN:2251-6727

musculoskeletal disorder were excluded from the study. The outcome measures used in this study were rate pressure product, 1 minute sit to stand, and Hand grip strength.

Protocol:



Procedure:

During the initial appointment, participants were screened, purpose and procedure of the study was explained to the patient. Demographic details were taken. Subjects were included in the study based on inclusion and exclusion criteria.

Hand grip strength, STS and MVO_2 of the patient were measured and calculated a day before intervention and on the day of discharge.

RPP was calculated by the product of systolic blood pressure (SBP) and heart rate (HR) such that RPP=SBP×HR/1,000.

Heart rate was measured by using radial pulse and the measurement of blood pressure was done using sphygmomanometer.

HGS was measured according to the American Society of Hand Therapy (ASHT) guidelines[16].

STS was done[17].

Data Analysis:

Data analysis was done using software Python version 3.9. To find out the correlation between the variables, Karl Pearson coefficient was used and for the comparison of pre and post data and independent t-test was used.

Result:

Total no. of subjects included in this study were 50 out of which 41 were males and 9 were females. Mean age was 56.96 ± 8.97 SD.

Table 1 shows correlation of pre MVO_2 with pre HGS(R), HGS(L) and Pre-STS which is not statistically significant with the P-value of 0.35, 0.12, and 0.5, respectively.

Pre MVO2	Pre HGS (R)	Pre HGS (L)	Pre STS
Pearson correlation	0.135543	0.221347	0.097809
P-value	0.35	0.12	0.5
N	50		

Table 1 shows correlation of Pre MVO_2 with pre HGS (R), pre HGS (L) and pre-STS

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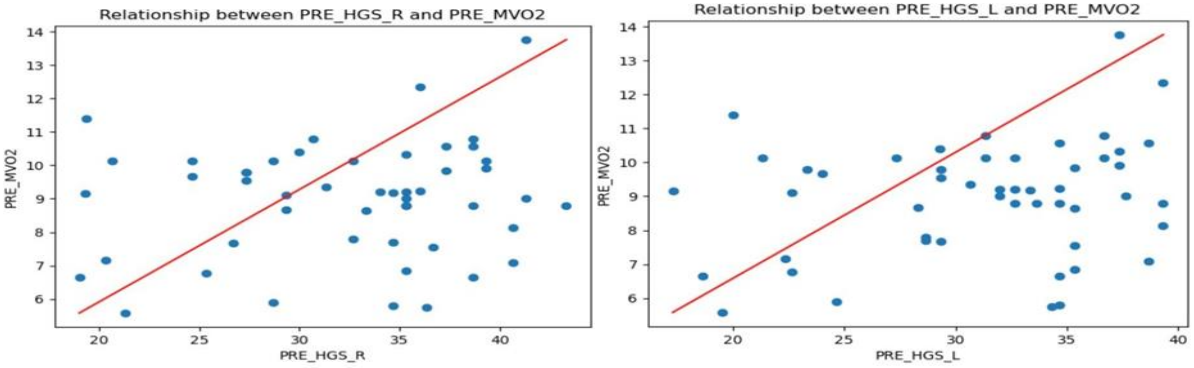
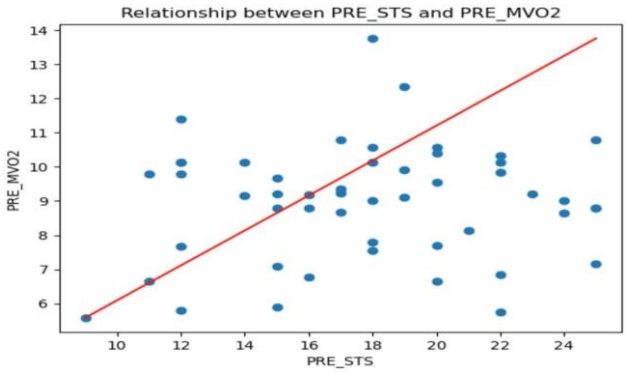


Graph 1 shows correlation of Pre MVO_2 with pre HGS (R)and pre HGS (L)

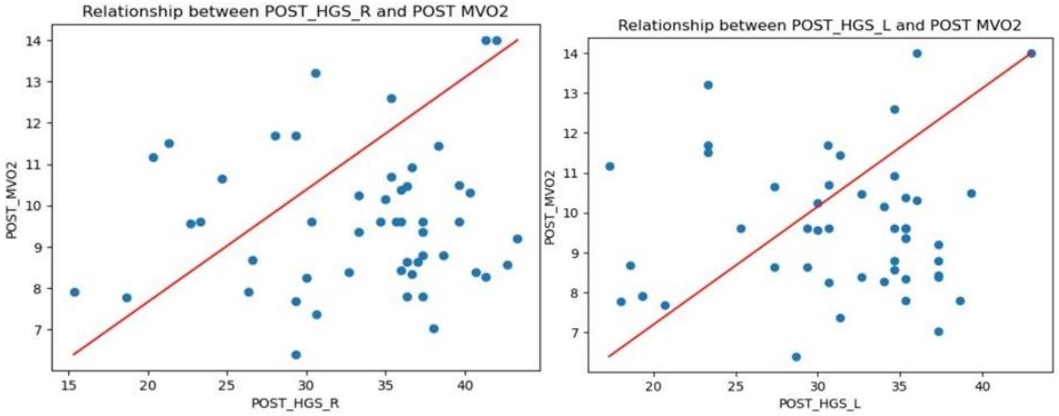


Graph 2 shows the correlation of Pre MVO_2 with pre-STS

Table 2 shows correlation of post MVO_2 with post HGS(R), HGS(L) and Post-STS which is not statistically significant with the P-value of 0.48, 0.51, and 0.95 respectively

Post MVO_2	**Post HGS(R)**	**Post HGS(L)**	**Post STS**
Pearson correlation	0.103196	0.094728	0.009056
P-value	0.48	0.51	0.95
N	50		

Table 2 shows correlation of Post MVO_2 with post HGS (R), post HGS (L) and post-STS



Graph 3 shows correlation of Post MVO_2 with post HGS (R)and post HGS (L)

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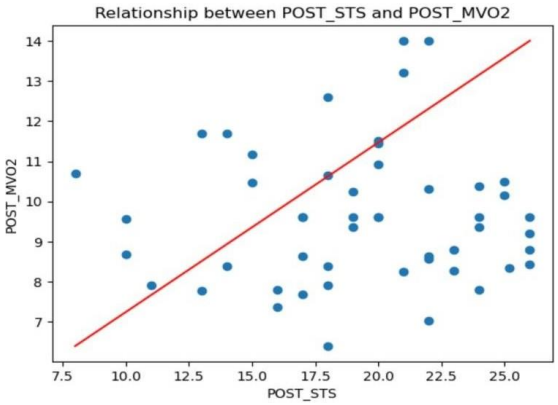

Graph 4 shows correlation of Post MVO2 with post STS

Table 3 shows the comparative values of Pre and Post HGS (R), HGS (L), MVO2 and STS, respectively. The P-values of all the variables are statistically insignificant

	Variable	MEAN	SD	P-VALUE
PRE	**HGS (R)**	32.40	6.56	0.41
POST		33.4	6.64	
PRE	**HGS (L)**	31.12	6.09	0.81
POST		31.29	6.22	
PRE	**MVO2**	8.96	1.7	0.062
POST		9.60	1.7	
PRE	**STS**	17.78	4.26	0.093
POST		19.28	4.59	

Table 3: Comparison between pre and post variables of HGS (R), HGS (L), MVO2 and STS

Discussion:

The purpose of this study was to analyze the correlation of MVO2 with hand grip strength and sit-to-stand test in CAD patients who underwent angioplasty.

The total participants in this study were 52, out of which 2 were excluded because of their co-morbidities (knee osteoarthritis and hand deformity), they were unable to perform STS and HGS tests.

Diminished cardiac functions due to coronary artery disease results in an imbalance between oxygen supply and heart demands. Inconsistency in myocardial oxygen demand in response to the discrepancy in coronary circulation can be measured as myocardial oxygen consumption index (MVO2)[18]. In this study, Myocardial oxygen consumption index (MVO2) was taken by the indirect method i.e., Rate pressure product (RPP). The formula to calculate MVO2 by means of RPP is Systolic blood pressure (SBP) × heart rate ÷ 1000.

Few studies have shown the relationship of MVO2 and HGS, pre- and post-surgery or intervention in CAD patients and can be used to predict MVO2 and physical capacity amid population having cardiac disorders[19,20]. After the data analysis of this study, it was found that there was a weak positive correlation between pre MVO2 and pre HGS (R-0.135 and L-0.221) which was not statistically significant (p-value – 0.35 and 0.12 respectively).

The readings of HGS might be hampered due to canula insertion as some subjects were complaining of pain and discomfort while performing the HGS test.

Sit-to-stand test was originated to evaluate the strength of lower limb muscles[21]. A study has shown the correlation of STS and peak oxygen consumption in normal (healthy) individuals[22] and STS can also help in distinguishing the high-level risks from low-level risks for cardiovascular incidents in patients having coronary artery disease (CAD)[23]. In this study, we have taken a type of sit-to-stand tests i.e., one minute sit-to-stand. The components included in one minute STS were Heart Rate, SpO2 level, and breathlessness. To

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JCHR (2024) 14(3), 1875-1881 | ISSN:2251-6727

assess breathlessness, Borg rate of perceived exertion (BRPE) scale was used. There was also a weak positive correlation between pre MVO2 and pre STS (0.097) which was not statistically significant (p- value – 0.5) in the present study.

When the post intervention data was analyzed, the result showed that there was a weak positive correlation of post MVO2 and HGS (R-0.103, L-0.094) along with STS (0.009) but it was not statistically significant (p-value – 0.48, 0.51 and 0.95 respectively). There might be variations in the post intervention readings of HGS and STS as few subjects were lethargic, complaining of fatigue, and generalized weakness.

After the analysis of pre and post data, the comparison of pre-post MVO2, HGS, and STS was done.

This study showed that there was a weak positive correlation in both pre and post data but during the comparison, the weak positive correlation of post data was even weaker than the pre data.

Limitations of the Study

- Duration of the study was short.
- The sample size of the study was small

Scope Of Future Research

- Hand grip strength exercises can be introduced before and after angioplasty.
- The post angioplasty readings of HGS and STS can also be taken on the follow-up day.

Conclusion

From this study, we can conclude that there is a weak positive correlation of pre and post MVO2 with pre and post HGS and STS which is not statistically significant.

After the comparison of pre and post data of MVO2, HGS, and STS; we can conclude that there was an increase in strength and physical capacity of the subjects but it was not statistically significant.

More research is needed to identify the factors affecting the correlation of MVO2 with HGS and STS.

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