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**Prognosis of Percutaneous Intervention of a Left Main Coronary Artery Stenosis Without the Use of Intravascular Imaging**

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**Abstract**

Objectives

The aim of this study was to assess the prognosis in patients with left main coronary artery stenosis one year after percutaneous coronary intervention (PCI).

Methods

Our study included 40 patients who underwent PCI for left main coronary artery

stenosis without the use of intravascular ultrasound (IVUS). Patients were followed for a year, and the prognostic effect of PCI on a composite end-point of revascularization, new myocardial infarction, cardiac death, and on all-cause mortality was assessed in multivariable Cox analysis.

Results

The multivariable analysis showed a good prognosis in patients receiving PCI with a total event rate of 7.5%. The independent predictors for major adverse cardiac events (MACE) were diabetes (p = 0.02). Other prognostic factors included in the model were gender, age, smoking, body mass index (BMI), hypertension, the complexity of the vessel, and ejection fraction.

Conclusion

PCI for left main coronary artery stenosis without the use of IVUS has a good prognosis after one year of clinical follow-up.



**Categories:** Cardiology

**Keywords:** ischemic heart disease, left main stem, intravascular imaging, percutaneous coronaryintervention, coronary artery stenosis

**Introduction**

Left main coronary artery disease (LMCAD) is associated with significant morbidity and mortality. The relative risk of perioperative mortality for patients with significant LMCA stenosis compared with patients without LMCAD is 1.3. The five-year mortality in coronary-artery bypass grafting (CABG) patients with three-vessel disease is 10.7%, compared with 15.8%

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in patients with LMCAD [1-4]. Conventionally, CABG is recommended for most patients with LMCAD [5-6].

However, more recently, randomized trials have shown that percutaneous coronary intervention (PCI) might be an acceptable alternative for such lesions in certain cases [7-10]. This is particularly true in patients with coronary artery disease of low or intermediate anatomical complexity [9]. With recent advances in an improved risk factor profile, careful patient selection, newer drug-eluting stents (DES), and improved intravascular imaging modalities, the use of PCI is expanding.

The aim of this study was an evaluation of clinical outcomes, including unstable angina, myocardial infarction, target vessel revascularization, and death in patients undergoing left main stem stenting without the use of intravascular imaging. Informed consent was taken from all participants in the study which abided by the Declaration of Helsinki.

**Materials And Methods**

**Enrollment, randomization, and follow-up**

Patients were assessed for eligibility by interventional cardiologists in collaboration with cardiac surgeons. Inclusion criteria included stenosis of the left main coronary artery of 50% or more, as estimated visually, with a consensus for eligibility for revascularization with either PCI or CABG and patients with a low-to-intermediate anatomical complexity of coronary artery disease (SYNTAX score 32 or less). Exclusion criteria included left main stem disease, along with triple vessel disease, and patients with a high anatomical complexity of coronary artery disease (Synergy Between PCI with Taxus and Cardiac Surgery (SYNTAX) score more than 32).

A history was taken and a detailed examination was done for all patients. Twelve-lead electrocardiography was performed before and after the procedure. Levels of the troponin were measured at the baseline and at 12 and 24 hours after the procedure. Clinical follow-up was performed at one month, six months, and one year. Echocardiography was done at the baseline and then at one year during follow-up. Risk factors were managed according to standard protocols, and guideline-directed medical therapy was recommended for all the patients.

**Revascularization strategies and medications**

The technique of performing PCI is described in detail elsewhere [11]. Intravascular ultrasonographic guidance was not used. Drug-eluting stents were deployed in all patients. Anticoagulation was achieved with heparin during the procedure and with glycoprotein (GP) IIb/IIIa inhibitors in the initial 12 hours post procedure. Dual antiplatelet therapy was advised for all patients.

**Assessment of risk and follow-up for adverse outcomes**

A team of cardiologists was involved in the follow-up of patients. Patients were contacted after a year by telephone, as well as scheduled consultations to assess for adverse events. Three patients were lost to follow-up due to change of permanent address and telephone numbers. Outcomes included in major adverse cardiac events (MACE) were cardiac death, death due to other causes, myocardial infarction, unstable angina, and target vessel revascularization (TVR).

**Statistics**

The distribution of variables was assessed using the Kołmogorov-Smirnov test. Statistical analysis results are expressed as the means ± SD. The t-test and one-way analysis of variance



2018 Mahmood et al. Cureus 10(6): e2857. DOI 10.7759/cureus.2857 2 of 10

(one-way ANOVA) were performed on normally distributed data. For analysis of nominal data and proportions (hypertension, and smoking), the x2 test was used. Cox proportional hazards analysis were used to identify risk factors for the occurrence of MACE during follow-up. All baseline, demographic, clinical, and angiographic variables were entered into the model. Results are reported as hazard ratios (HRs) and 95% CIs. All statistical tests were two-tailed, and p values were statistically significant at < 0.05. All data were analyzed using the Statistical Package for Social Sciences (SPSS) (IBM SPSS Statistics, Armonk, NY), V.20.0 software.

**Results**

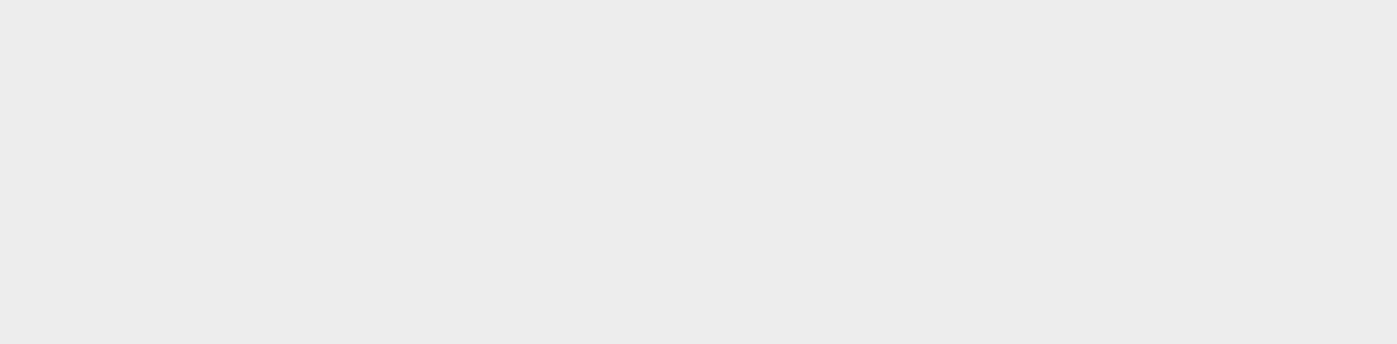
The mean age of our study sample was 59 ± 13.02 years. For the purpose of PCI, only DES (sirolimus, everolimus, rapamycin, zotarolimus) were used. Out of the 40 patients who underwent PCI for left main stem disease, 27 (67.5%) were men and 13 (32.5%) were women. Ten patients (25%) were smokers, while 30 (75%) were nonsmokers; nine (22.5%) patients were overweight, 14 (35%) had diabetes, and 13 (32.5%) were hypertensive. Four (10%) of the 40 patients in our study had multivessel disease.

No reflow phenomena were found in any of the patients during the procedure. All 40 (100%) patients were given adjunctive treatment with GP IIb/ IIIa antagonists in the catheterization laboratory, as well as for 12 - 24 hours post-procedure. With regard to maintenance therapy after PCI, 100% were receiving aspirin, clopidogrel, and nitrates, 97.5% received beta-blockers, 90% received angiotensin-converting enzyme inhibitors (ACEI), and 45% received diuretics. Baseline characteristics for the study sample are shown in Table [*1*](#page4).



2018 Mahmood et al. Cureus 10(6): e2857. DOI 10.7759/cureus.2857 3 of 10

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  |  |  |  |
|  |  | **Index** |  | **Frequency (n/%)** |  |  |
|  |  |  |  |  |  |  |
|  |  |  |  | |  |  |
|  |  | **Agea** |  | 59 |  |  |
|  |  | **Gender:** |  |  |  |  |
|  |  |  |  | |  |  |
|  |  | *Males* |  | 27/67.5 |  |  |
|  |  |  |  |  |  |  |
|  |  | *Females* | 13/32.5 | |  |  |
|  |  |  |  | |  |  |
|  |  | **Smoking** |  | 10/25 |  |  |
|  |  |  |  |  |  |  |
|  |  | **BMI** | 9/22.5 | |  |  |
|  |  |  |  | |  |  |
|  |  | **Diabetes** |  | 14/35 |  |  |
|  |  |  |  |  |  |  |
|  |  | **Hypertension** | 13/32.5 | |  |  |
|  |  |  |  | |  |  |
|  |  | **Multivessel disease** |  | 4/10 |  |  |
|  |  |  |  |  |  |  |
|  |  | **Ejection Fractionb** | 45±12 | |  |  |
|  |  | **Aspirin** |  | 40/100 |  |  |
|  |  |  |  |  |  |  |
|  |  | **Clopidogrel** | 40/100 | |  |  |
|  |  |  |  | |  |  |
|  |  | **Beta Blockers** |  | 39/97.5 |  |  |
|  |  |  |  |  |  |  |
|  |  | **ACEI** | 36/90 | |  |  |
|  |  |  |  | |  |  |
|  |  | **Nitrates** |  | 40/100 |  |  |
|  |  |  |  |  |  |  |
|  |  | **Diuretics** | 18/45 | |  |  |
|  |  |  |  |  |  |  |
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**TABLE 1: Baseline Characteristics of Patients Included in Study**

* Expressed as mean in years
* Expresses as mean with standard deviation

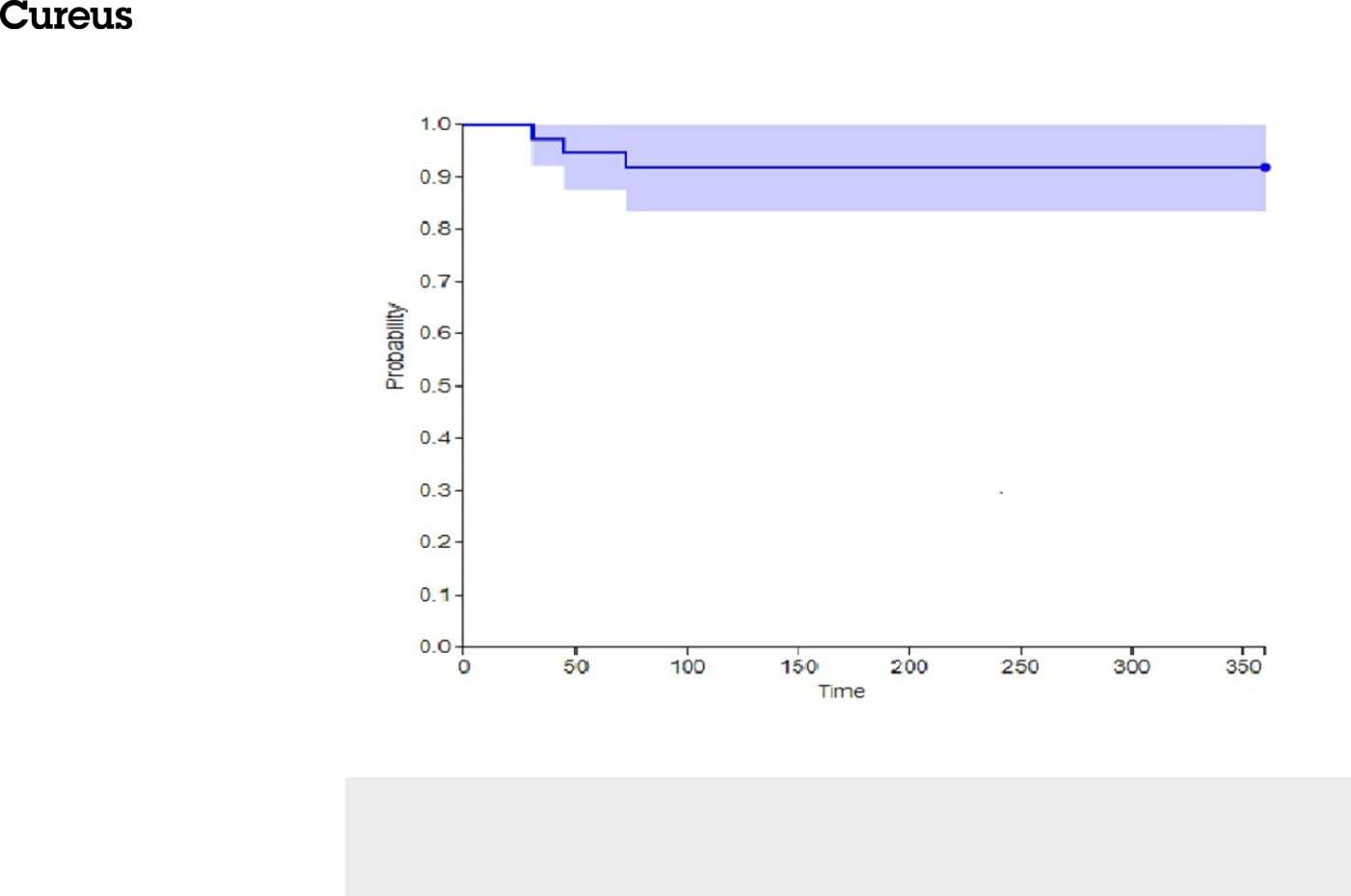
n: number; BMI: body mass index; ACEI: angiotensin converting enzyme inhibitors



Cumulative MACE for this study was 7.5% (three patients). The Kaplan Meier analysis is shown in Figure [*1*](#page5).



2018 Mahmood et al. Cureus 10(6): e2857. DOI 10.7759/cureus.2857 4 of 10



**FIGURE 1: Kaplan Meier analysis of subjects included in study**

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The one-year mortality was 5% (two patients): myocardial infarction 2.5% (one patient) and unstable angina episodes 2.5% (one patient), and no patient had target vessel revascularization. Among the patients with adverse events, one myocardial infarction patient died.

A multivariate Cox regression analysis with risk factors for coronary artery disease as predictive

variables and MACE as the dependent variable were carried out. Analysis showed that diabetes

(P = 0.02) was an independent predictor of MACE. Variables excluded by the model were age (P =

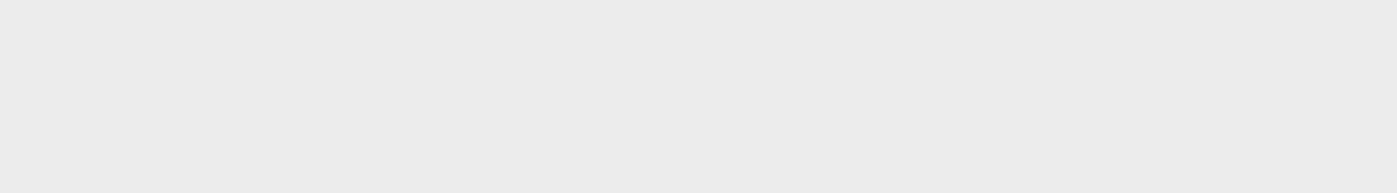
0.42), gender (P = 0.75), smoking (P = 0.42), body mass index (BMI) (P = 0.47), hypertension (P =

0.84), ejection fraction (EF) (P = 0.89), and multivessel disease (P = 0.28) as shown in Table [*2*](#page6).



2018 Mahmood et al. Cureus 10(6): e2857. DOI 10.7759/cureus.2857 5 of 10

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
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|  |  | **Index** |  | **Hazard Ratio** | **(95% CI)** |  | **P value** |  |  |
|  |  |  |  |  |  |  |  |  |  |
|  |  |  |  | |  |  | |  |  |
|  |  | Age |  | 1.18 (0.81 - 1.73) |  |  | 0.42 |  |  |
|  |  |  |  |  |  |  |  |  |  |
|  |  | Gender | 0.94 (0.72 - 1.23) | |  | 0.75 | |  |  |
|  |  |  |  | |  |  | |  |  |
|  |  | Smoking |  | 1.01 (0.99 - 1.03) |  |  | 0.42 |  |  |
|  |  |  |  |  |  |  |  |  |  |
|  |  | BMI | 1.08 (0.84 - 1.38) | |  | 0.47 | |  |  |
|  |  |  |  | |  |  | |  |  |
|  |  | Diabetes |  | 1.51 (1.11 - 2.06) |  |  | 0.02 |  |  |
|  |  |  |  |  |  |  |  |  |  |
|  |  | Hypertension | 0.96 (0.76 - 1.23) | |  | 0.89 | |  |  |
|  |  |  |  | |  |  | |  |  |
|  |  | Multivessel Disease |  | 1.18 (0.91 - 1.52) |  |  | 0.28 |  |  |
|  |  |  |  |  |  |  |  |  |  |
|  |  | Ejection Fraction | 1.03 (0.78 - 1.35) | |  | 0.84 | |  |  |
|  |  |  |  |  |  |  |  |  |  |
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**TABLE 2: Cox Regression Table With Hazard Ratio For Various Variables**

CI: confidence interval; BMI: body mass index



**Discussion**

Left main stem (LMS) disease has prognostic significance and is found in about 5% of patients admitted for coronary angiographies [12-13]. The Coronary Artery Surgery Study (CASS) showed significantly improved five-year mortality in CABG as compared to medical therapy (16% vs 43%) [14]. CABG is traditionally regarded as the standard treatment for LMS disease, but since the start of PCI era, interventional cardiologists have been rigorously assessing its role in LMS disease.

The high survival rate for post-CABG patients has been shown in multiple studies [15]. However, the Unprotected Left Main Trunk Intervention Multicenter Assessment (ULTIMA) registry demonstrated promising results for PCI to left main stem with 24% one-year mortality which was even lower in the low-risk group (3.4%) [16]. Biondi-Zoccai et al. [17] also demonstrated a MACE rate of 10.6 and mortality rate of 5.5% for PCI patients. Other registries comparing CABG to PCI also demonstrated similar MACE rates [18-19]. Two important aspects that came to light from these registries were the increased rates of target lesion revascularization (TLR) in the PCI group, while there was a higher incidence of cerebrovascular accidents (CVA) in the CABG patients. The Revascularization for Unprotected Left Main Coronary Artery Stenosis: Comparison of Percutaneous Coronary Angioplasty Versus Surgical Revascularization (MAIN-COMPARE) registry [20] also reported similar results.

The Study of Unprotected Left Main Stenting versus Bypass Surgery (LE MANS) was the first randomized controlled trials (RCT) and enrolled 105 patients with significant LMS disease (defined as > 50% stenosis angiographically) [21]. The primary endpoint was the change in the left ventricular ejection fraction (LVEF) at 12 months, while the secondary endpoint was a major adverse cardiac and cerebrovascular event (MACCE) at 30 days and one year. Surprisingly, there was a statistically significant improvement in LVEF with patients treated with PCI versus CABG (58% versus 54%). PCI was also associated with a lower MACE rate at 30 days (2% versus 13%) with a MACE being equivalent at one year in the two groups. The study did have a number of limitations, including a small sample size, high use of bare metal stents



2018 Mahmood et al. Cureus 10(6): e2857. DOI 10.7759/cureus.2857 6 of 10

(BMS), and a lower than the contemporary use of left internal mammary artery (LIMA) grafts.

The Synergy Between PCI With Taxus and Cardiac Surgery (SYNTAX) trial was the largest to compare PCI to CABG in LMS disease and demonstrated that if patients were divided into tertiles of syntax score (0-22, 23-32, and above 32), the results were comparable in the lower two tertiles. CABG showed better results as compared to PCI when the syntax score was above

1. [22-23].

Two recent studies showed conflicting results for coronary artery bypass (CABG) vs percutaneous coronary intervention (PCI) in left main coronary artery (LMCA) disease.

The EXCEL (Evaluation of XCIENCE vs Coronary Artery Bypass Surgery for Effectiveness of Left Main Revascularization) trial demonstrated non-inferiority of PCI with everolimus-eluting stents to CABG in low or intermediate SYNTAX score patients [7]. At three years, the MACE rate was 15.4% in the PCI group as compared with 14.7% in the CABG group (95% confidence interval (CI), 0.79 - 1.26) [7].

The NOBLE (Nordic-Baltic-British Left Main Revascularization) trial found that despite a similar mortality, the five-year MACE was higher after PCI as compared to CABG (28.9% for PCI vs 19.1% for CABG) (HR:1.48; 95% CI, 1.11 - 1.96) [24].

Two important factors which could explain the difference between the two trials were the under-utilization of intravascular ultrasound (IVUS) and use of first-generation stents in 11% of PCI patients in the NOBLE trial.

A number of factors can influence the outcome of stenting in left main stem diseases, such as lesion location, stent type, use of intravascular imaging, and complexity of lesion. The distal left main disease poses a particularly challenging vessel anatomy to treat [25]. The Drug-Eluting Stent for Left Main Coronary Artery Disease (DELTA) registry compared ostial/mid-shaft lesions versus distal lesions. The higher rate of TLR was found with distal lesions [26]. In our study, cases with the distal left main disease were relatively fewer, which could explain the good prognosis. Moreover, the Culotte technique appeared to be associated with better outcomes as opposed to the T-stent technique with an in-stent restenosis (ISR) rate of 21% and 56% and a TLR rate of 15% and 56%, respectively [25].

In-stent restenosis and thrombosis are two of the primary concerns in patients coming for PCI. Pandya et al. showed that use of BMS was associated with poorer outcomes than DES [27]. The Intracoronary Stenting and Angiographic Results: Drug-Eluting Stents for Unprotected Coronary Left Main Lesions (ISAR LEFT MAIN and ISAR LEFT MAIN 2) trials were carried out to compare different types of DES [28-29]. These studies proved that outcomes were not influenced by stents (DES) from the same generation.

Appropriate sizing and apposition of stents in LMS disease play an important role in the prevention of ISR and thrombosis. There are no large trials investigating the use of IVUS for PCI but data from certain relatively small studies, such as the MAIN-COMPARE study, point towards improved outcomes with the use of IVUS [30]. In our study, we did not use intravascular imaging due to non-availability of IVUS in our hospital. Patients who agreed to undergo PCI were informed of this limitation. The results in our study were comparable to aforementioned studies, hence showing that absence of intravascular imaging may not be considered a major setback for intervention in left main stem disease.

**Limitations**

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2018 Mahmood et al. Cureus 10(6): e2857. DOI 10.7759/cureus.2857 7 of 10

The sample size was relatively small due to stringent inclusion criteria of our study.

**Future**

In recent times, the outcomes of PCI in LMS disease have improved drastically. This can be attributed to improved stent technology, drug-delivery systems, intravascular imaging, and more potent antiplatelet drugs. More randomized controlled trials (RCTs) are required to establish PCI as a standard treatment option for LMS disease in an era dominated by CABG as the gold standard.

**Conclusions**

Percutaneous coronary intervention to left main coronary artery stenosis without the use of intravascular imaging showed good prognosis. It would not only save a huge amount of time for physicians during procedures but also prevent a financial burden on patients if they cannot afford intravascular imaging. Hence, more patients will benefit from left main coronary artery interventions, which are considered high-risk by interventionists. Further studies with large sample sizes and longer follow-up will be required to properly ascertain a full prognosis.

**Additional Information**

**Disclosures**

**Human subjects:** Consent was obtained by all participants in this study. Rehman MedicalInstitute Ethical Review Committee issued approval not applicable. Approved. **Animal** **subjects:** All authors have confirmed that this study did not involve animal subjects or tissue. **Conflicts of interest:** In compliance with the ICMJE uniform disclosure form, all authorsdeclare the following: **Payment/services info:** All authors have declared that no financial support was received from any organization for the submitted work. **Financial relationships:** All authors have declared that they have no financial relationships at present or within the previous three years with any organizations that might have an interest in the submitted work. **Other relationships:** All authors have declared that there are no other relationships oractivities that could appear to have influenced the submitted work.

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2018 Mahmood et al. Cureus 10(6): e2857. DOI 10.7759/cureus.2857 8 of 10

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**Prognostic significance of serum potassium level for major adverse cardiac events and death**

**in patients with coronary atherosclerotic disease**

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**Abstract**

**Introduction:** *Serum potassium levels have been shown in some animal studies to be associated with the**process of atherosclerosis. We decided to assess the correlation of serum potassium level in ischemic heart disease patients with disease severity and its relationship with prognosis in terms of major acute cardiac events (MACE).* **Material and methods:** *This was a cross-sectional cohort study carried out at cardiology department of Rehman**Medical Institute, from July 2016 to 31st Aug. 2018 a period of 26 months. 622 patients were included in the study. Clinical and angiographic characteristics were assessed based on the serum potassium level. Correlation of serum potassium level with Synergy between Percutaneous Coronary Intervention with Taxus and Cardiac Surgery (SYNTAX) and Gensini scores was also evaluated. Follow up for MACE was carried out after one year.*

**Results:** *Mean serum potassium level was 3.93 ± 0.95 (mEq/l) in coronary artery disease patients. Serum**potassium level showed negative correlation with SYNTAX score (r = –0.60, p < 0.05) and Gensini score (r = –0.64, p < 0.05). There was also a significant difference between low and high potassium level in relation to the multi-vessel disease on coronary angiography (p < 0.05). Low potassium level was a good predictor of adverse outcomes as shown by Kaplan-Meier analysis. Multivariate Cox regression analysis showed that serum potassium level and diabetes were independent predictors of MACE (p < 0.05).*

**Conclusion:** *Low serum potassium level is correlated with more severe coronary atherosclerosis. Low potassium**levels are associated with significantly poor outcomes.*

**Key words:** coronary artery disease, coronary angiography, prognosis, potassium

Acta Angiol 2020; 26, 2: 58–64

**Introduction**

Cardiovascular disease is the leading cause of morbidity and mortality globally [1]. A lot of research is underway to better understand the causes of cardiovascular dis-ease as well as the means to reduce such an alarming incidence. One such modifiable factor which has come under light recently is serum potassium level.

Hypokalemia has multiple effects on the myocardi-um and predisposes to arrhythmias while on the other hand hyperkalemia slows down conduction [2].

Studies have shown that elevated potassium levels induce arterial smooth muscle relaxation and cause vasodilatation due to involvement of K+ channels and Na+/K+-ATPase [3–6]. Elevated serum potassium levels also play a role in the inhibition of platelet ag-

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58 www.journals.viamedica.pl/acta\_angiologica

Afrasyab Altaf et al., **Serum potassium and coronary artery disease**

gregation and arterial thrombus formation, and hence coronary atherosclerosis [7–10].

However, a few recent studies [11, 12] have demon-strated the correlation between elevated serum po-tassium levels and increased atherosclerosis as well as the severity of coronary artery disease, which would contradict the above-given explanations. So, keeping in mind the results of such studies, we hypothesized that lower serum potassium may be associated with an increased risk of cardiovascular events and mortality.

**Material and methods**

This was a cross-sectional (for correlation) and co-hort (for MACE) study carried out at cardiology depart-ment of Rehman Medical Institute, Peshawar, which is one of the biggest tertiary care hospitals in KPK, Pakistan providing 24/7 cath. lab facility, from July 2016 to August 2018, a period of 26 months. A total of 622 patients were included in the study population using universal sampling technique. All those patients were included who gave consent for inclusion and were admitted or discharged with the diagnosis of ischemic heart disease fulfilling the criteria of either stable angina, unstable angina or myo-cardial infarction [13]. Patients who were admitted due to non-cardiac causes like severe pneumonia, ARDS, and renal failure were excluded from the study population. All baseline demographic characteristics including age, gender, diabetes, hypertension, body mass index (BMI), smoking, alcohol consumption, and medication use were noted for each patient from history and hospital records. For measured variables, blood samples were taken at admission and sent for analysis of serum potassium, hemoglobin level, troponin level, CRP level, creatinine, and urea, total cholesterol (TC), low-density lipopro-tein cholesterol (LDL), triglyceride (TG), high-density lipoprotein cholesterol (HDL) levels (Cobas B221 and 6000, Roche-Switzerland). All cases were divided into two groups (Low and High potassium groups) based on median serum potassium levels.

**Definition of risk factors**

**and clinical syndromes**

Hypercholesterolemia was diagnosed in patients who had been given lipid-lowering medication or had a history of total cholesterol levels > 200 mg/dl [14]. Pa-tients were diagnosed as hypertensive if they were doc-umented to have a systolic blood pressure 140 mm Hg or a diastolic blood pressure 90 mm Hg on more than two occasions (but not during the angiogram proce-dure) or were already on antihypertensive therapy [15]. Patients were diagnosed with diabetes mellitus if they had a documented fasting glucose value > 126 mg/dl or HbA1C of >7 on one or more occasion or were tak-

ing insulin or oral hypoglycemic medications for diabe-tes mellitus. Myocardial infarction (MI) on presentation was diagnosed by a history of chest pain, electrocar-diogram showing new ST-segment/T wave changes or new pathological Q waves or new left bundle branch block (LBBB), echocardiographic evidence of new regional wall motion abnormality and two recordings of hs-troponin levels showing rise and/or fall in values with at least one value above 99th percentile upper reference limit (URL). Body mass index was calculated by dividing the weight of the patient in kilograms by the square of height in meters. Active Smokers were defined as someone who smoked > 100 cigarettes, cigars, or pipes in their lifetime and still smoked in the last 28 days. Smokers were classified as former only if they had smoked > 100 cigarettes, cigars, or pipes in their lifetime and has not smoked in the last 28 days preceding the date of angiography [16].

**Angiographic evaluation**

Coronary angiography was performed with Selding-er technique in all the patients [17]. All angiographic assessments were done by two independent cardiolo-gists. In case of difference in opinion, a third cardiologist was consulted. Patients were then divided into a con-trol group (normal coronary vessels) and cases group (coronary arteries with the disease). Control group included 100 subjects and 622 cases with coronary artery stenosis ≥ 50% of the vessel diameter were included in the CAD group (622 cases: 371 men and 251 women). SYNTAX and Gensini scoring systems were used to assess the severity of coronary stenosis in all cases. In SYNTAX score calculation each coronary lesion producing ≥ 50% diameter stenosis in vessels

1. 1.5 mm was scored separately using the SYNTAX score algorithm available on the Internet from the and added to obtain the overall SYNTAX score. Gensini score is based on the severity of lesion narrowing, number of lesions, lesion location, and influence of collaterals [18, 19].

Major adverse cardiac events (MACE) for the pur-poses of follow-up were as follows: (1) acute myocardial infarction; (2) decompensated heart failure; (3) target vessel revascularization and (4) mortality due to cardiac disease [20].

This study was evaluated and approved by the Re-search evaluation and Ethics Committee of Rehman Med-ical Institute. The study abided by the principles of the Declaration of Helsinki. Written and informed consent was obtained from each patient included in the study.

**Statistical analysis**

Data were analyzed for normality using the Kolmogo-rov-Smirnov (KS) test. Continuous data are presented

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Acta Angiol, 2020, Vol. 26, No. 2

**Table 1.** Baseline characteristics and angiographic features of study groups based on serum potassium levels



|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Variable** | **Serum potassium (< 4 mEq/l)** | | **Serum potassium (4 mEq/l or above)** | | |
| Number of patients | 349 | |  | 273 | |
| Age (years) | 63.72 ± 4.35 | | 62.54 | | ± 10.23 |
| Gender (m/f) | 210/139 (60/40%) | | 161/112 (59/41%) | | |
| Ejection fraction (%) | 49.98 | ± 10.55 | 49.87 | | ± 10.35 |
| Blood sugar | 147.31 ± 96.06 | | 146.40 ± 80.14 | | |
| Serum creatinine | 1.01 | ± 0.23 | 1.01 | | ± 0.22 |
| Hemoglobin (g/dl) | 14.2 | ± 1.71 | 14.39 ± 1.72 | | |
| BNP (pg/ml) | 395.12 | ± 629.35 | 487.12 | | ± 800.72 |
| Hs-Troponin | 3443 | ± 4414 | 4584 | | ± 5796 |
| CRP | 8.00 ± 11.19 | | 7.91 | ± 10.59 | |
| Diabetes | 122 | (35%) | 85 | (31%) | |
| Hypertension | 192 | (55%) | 158 | | (58%) |
| Smoking | 105 | (30%) | 90 | (33%) | |
| Hyperlipedemia | 98 (28%) | | 68 | (25%) | |
| Anti-Platelet drugs | 345 | (99%) | 273 | (100%) | |
| Beta blocker | 311 | (89%) | 235 | | (86%) |
| RAAS inhibitors | 195 | (56%) | 145 | | (53%) |
| Nitrates | 188 | (54%) | 156 | | (57%) |
| Digoxin | 70 (20%) | | 49 | (18%) | |
| Diuretics | 70 (20%) | | 46 | (17%) | |
| Lipid lowering agents | 209 | (60%) | 169 | | (62%) |
| SYNTAX score | 37.48 ± 7.28 | | 26.76 ± 6.34\* | | |
| Gensini score | 77.56 | ± 13.05 | 56.46 ± 12.24\* | | |
| Multi-vessel disease | 174/(50%) | | 96/(35%)\* | | |
| LAD | 220/(63%) | | 150/(55%) | | |
| LCX | 157/(45%) | | 109/(40%) | | |
| RCA | 132/(38%) | | 93/(34%) | | |

\*P ≤ 0.05; CRP: C-reactive protein; RAA: renin angiotensin aldosterone system inhibitors; LAD: left anterior descending artery; LCX: left circumflex artery; RCA:

right coronary artery

as means ± SD Between-group comparisons were performed using t-test. Categorical data were pre-sented as percentages and analyzed using c 2 test. The correlation between serum potassium level, Syntax and Gensini scores were examined by Pearson correlation analysis. and Kaplan Meyer analysis was used for sur-vival analysis. Differences with p values < 0.05 were considered statistically significant. Multivariate Cox re-gression analysis was done to examine the independent predictors of MACE

**Results**

**General clinical data comparison**

Mean serum potassium level was 3.93 ± 0.95 (mEq/l) in coronary artery disease patients. Patients were divided

based median serum potassium level (4 mEq/l) and com-parison was made of baseline characteristics. There were no significant differences in clinical characteristics at base-line between the two groups with high and low potassium levels (p > 0.05) (Table 1). All patients received similar medication such as anti-platelets, beta-blockers, Renin An-giotensin Aldosterone system (RAAS) inhibitors, statins, ni-trates and diuretics. Patients’ characteristics with and with-out MACE were also compared which showed a significant difference in serum potassium level, BMI, ejection fraction, SYNTAX score, Gensini Score and multi-vessel disease (p ≤ 0.05) (Table 2).

**Angiographic assessment and correlation**

Angiographic analysis based on serum potassium level demonstrated that there was a significant difference

60 www.journals.viamedica.pl/acta\_angiologica

Afrasyab Altaf et al., **Serum potassium and coronary artery disease**

**Table 2.** Patient characteristics and angiographic features of study groups according to MACE



|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Variable** | **Patients without MACE** | | **Patients with MACE** | |
| Number of patients | 601 | |  | 21 |
| Age (years) | 61.35 ± 5.62 | | 63.32 ± 8.46 | |
| Gender (m/f) | 330/271 (55/45%) | | 12/9 (60/41%) | |
| Serum potassium (< 4 mEq/l) | 3.38 | ± 0.44 | 4.62 ± 0.56\* | |
| BMI | 22.43 ± 1.12 | | 25.11 ± 1.15\* | |
| Ejection fraction (%) | 54.51 ± 8.14 | | 42.35 ± 7.29\* | |
| Blood sugar | 140.31 ± 87.27 | | 148.40 ± 72.44 | |
| Serum creatinine | 1.11 | ± 0.35 | 1.23 ± 0.28 | |
| Hemoglobin (g/dl) | 13.4 | ± 1.53 | 14.38 ± 1.67 | |
| BNP (pg/ml) | 346.19 | ± 601.45 | 501.17 ± 780.58 | |
| Hs-troponin | 3566 | ± 3942 | 4731 ± 5385 | |
| CRP | 6.00 | ± 9.12 | 8.34 | ± 11.89 |
| Diabetes | 222 | (37%) | 13 (62%)\* | |
| Hypertension | 301 | (50%) | 12 | (57%) |
| Smoking | 186 | (31%) | 7 (35%) | |
| Hyperlipedemia | 144 | (24%) | 6 (29%) | |
| Anti-platelet drugs | 601 (100%) | | 20 | (95%) |
| Beta blocker | 541(90%) | | 18 | (86%) |
| RAAS inhibitors | 330 | (55%) | 11 | (54%) |
| Nitrates | 330 | (55%) | 12 | (57%) |
| Digoxin | 108 | (18%) | 4 (20%) | |
| Diuretics | 150 | (25%) | 6 (30%) | |
| Lipid lowering agents | 360 | (60%) | 13 | (62%) |
| SYNTAX score | 25.48 ± 6.24 | | 39.76 ± 7.37\* | |
| Gensini score | 57.56 | ± 12.16 | 79.46 ± 10.43\* | |
| Multi-vessel disease | 204/(34%) | | 12/(57%)\* | |
| LAD | 348/(58%) | | 13/(62%) | |
| LCX | 288/(42%) | | 9/(43%) | |
| RCA | 198/(33%) | | 8/(38%) | |

\*P ≤ 0.05; CRP: C-reactive protein; RAA: renin angiotensin aldosterone system inhibitors; LAD: left anterior descending artery; LCX: left circumflex artery; RCA:

right coronary artery

between low and high potassium level groups in terms of multi-vessel disease, SYNTAX score and Gensini score (p < 0.05). The involvement of the type of vessel was similar in both groups (p > 0.05) (Table 1).

The mean SYNTAX score all patients was 32.78 ± 8.70 while the Gensini score was 68.30 ± 16.46. The results of Pearson’s correlation indicate that there was a significant negative correlation between the concentra-tion of potassium and SYNTAX score (r = –0.60, p < 0.05). and Gensini score (r= –0.64, p < 0.05) (Fig. 1).

**Survival and multivariate analysis for MACE**

For analysis, we assessed Kaplan-Meier curves accord-ing to median value of serum Potassium level (median

* 4 mEq/l) (Fig. 2). The Kaplan-Meier curves revealed a significantly worse cumulative outcome in patients with serum Potassium level below 4 mEq/l.

Cumulative MACE for this study was 3.4% (21 pa-tients). The 180 days mortality was 1.28% (8 patient), myocardial infarction 1.76% (11 patients), target vessel revascularization was 1.1% (7 patients) and cardiac failure was 1.1% (7 patients) (Tables 3, 4).

**Discussion**

Data from the Systolic Hypertension in the Elderly Program (SHEP) [21] trial has shown that normal potassium level has significantly reduced hazard ration

www.journals.viamedica.pl/acta\_angiologica 61

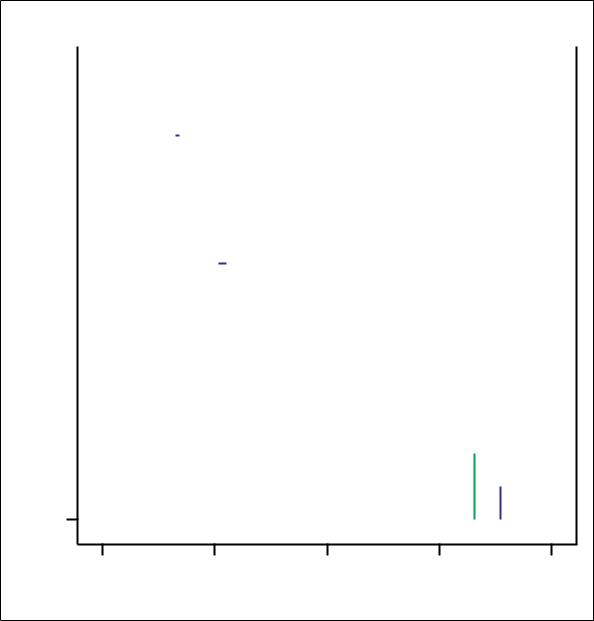
Acta Angiol, 2020, Vol. 26, No. 2

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| **A** 60 | |  |  |  |  |  |  |  |  |  |  |  |  |  |  | **B** 120 | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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| 40 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 100 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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| 40 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 80 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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| 30 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 60 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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| 20 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 40 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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| 10 |  |  |  | SYNTAX score | | |  |  |  |  |  |  |  |  |  | 20 |  |  |  | GENSINI score | | |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 0 |  |  |  |  |  |  |  |  |  |  |  |  | 0 |  |  |  |  |  |  |  |  |  |  |  |  |
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| 0 | | | | 2 | | | 4 | | | 6 | | | 8 | | | 0 | | | | 2 | | | 4 | | | 6 | | | 8 | | |
|  |  |  |  |  |  |  | Serum potassium | | |  |  |  |  |  |  |  |  |  |  |  |  |  | Serum potassium | | |  |  |  |  |  |  |
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**Figure 1.** Correlation of serum potassium level with (a) SYNTAX score and (b) Gensini score. Pearson’s correlation analysis shownegative correlation for both [SYNTAX score (r = –0.06) and Gensini score (r = – 0.64)]

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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|  |  |  |  |  |  |  |  |  |  |  |  |  | Survival functions | | | | | | | | | | | | | | | | |
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|  | 1.0 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | Potasium | | | | | |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | Serum potasium < 4 mEq/l | | | | | | |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | Serum potasium 4 mEq/l | | | | | | |
|  | 0.8 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | or above | | | | | | |
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| Cum survival | 0.6 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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| 0.4 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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|  | 0.2 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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0.0

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 0 | 50 | 100 | 150 | 200 |
|  |  | Time |  |  |

**Figure 2.** Kaplan Meier analysis based on median serum po-tassium level. A significant difference between low and high potassium for adverse outcomes (p < 0.05). Time in number of days

for cardiovascular events including stroke and coro-nary vessels related events. Moreover, animal studies have shown that high potassium diets normalize blood pressure and provide protection against atherosclerosis in arteries [22].

Increased potassium content in diets plays a role reduction of vascular lesions owing to decreased en-dothelial injuries and less adherence and infiltration of macrophages into the vascular wall [11].

Other mechanisms explaining the role of increased potassium levels in the maintenance of normal blood

**Table 3.** Univariate analysis for MACE



|  |  |  |
| --- | --- | --- |
|  | **Univariate analysis** | |
|  |  |  |
|  | **HR (95%CI)** | **p value** |
| Gender (M vs. F) | 1.131 (0.151–3.167) | 0.31 |
| Age (≥ 60 vs. < 60) | 0.519 (0.212–1.926) | 0.32 |
| Serum potassium | 1.426 (1.077–1.413) | 0.02 |
| (≥ 4 mEq/l vs. < 4mEq/l) |  |  |
| Ejection fraction | 1.242 (0.551–1.236) | 0.05 |
| (≥ 50% vs. < 50%) |  |  |
| Hypertension (present | 1.986 (0.191–47.626) | 0.45 |
| vs. absent) |  |  |
| Diabetes (present | 1.378 (1.107–1.412) | 0.03 |
| vs. absent) |  |  |
| BMI (≥ 25 vs. < 25) | 0.658 (0.421–1.229) | 0.19 |
| Smoking (yes vs. no) | 1.716 (0.635–66.137) | 0.67 |
| Total cholesterol (≥ 200 | 1.109 (0.229–6.443) | 0.75 |
| mg/dl vs. < 200 mg/dl) |  |  |
| BNP (≥ 100 pg/ml vs. | 0.582 (0.316–1.572) | 0.37 |
| < 100 pg/ml) |  |  |
| Troponin (≥ 14 mg/l vs. | 0.088 (0.087–1.983) | 0.31 |
| < 14 ng/l) |  |  |
| Creatinine (≥ 1.2 mg/dl | 0.865 (0.794–1.181) | 0.28 |
| vs < 1.2 mg/dl) |  |  |
| Family history of CADc | 1.927 (0.251–59.172) | 0.43 |
| (present vs. absent) |  |  |
| Multi-vessel disease | 0.229 (0.026–67.472) | 0.14 |
| (present vs. absent) |  |  |

BMI: body mass index; BNP: basic natriuretic peptide; CAD: coronary artery disease

pressure as well as prevention of coronary atheroscle-rosis are as follows; a) inhibition of platelet aggregation and arterial thrombosis; b) reduction in renal vascular resistance and increase in glomerular filtration rate;

62 www.journals.viamedica.pl/acta\_angiologica

Afrasyab Altaf et al., **Serum potassium and coronary artery disease**

**Table 4.** Multivariate regression analysis for MACE



|  |  |  |
| --- | --- | --- |
|  | **Multivariate analysis** | |
|  |  |  |
|  | **HR (95%CI)** | **p value** |
| BMI (≥ 100 pg/ml vs. | 0.481 (0.613–2.754) | 0.54 |
| < 100 pg/ml) |  |  |
| Serum potassium | 1.278(1.073–1.662) | 0.03 |
| (≥ 4 mEq/l vs. < 4 mEq/l) |  |  |
| Ejection fraction | 1.481 (0.737–1.551) | 0.32 |
| (≥ 50% vs. < 50%) |  |  |
| Diabetes (present | 1.331 (1.109–1.517) | 0.04 |
| vs. absent) |  |  |
| Multi-vessel disease | 0.316 (0.030–71.482) | 0.68 |
| (present vs. absent) |  |  |

* inhibition of free radical formation from vascular en-dothelial cells and macrophages; d) inhibition of vascular smooth muscle cell proliferation; and e) suppression of reactive oxygen species overproduction [23].

Such established findings are in contradiction to two previous studies [11, 12] which have reported that hyperkalemia is associated with increased atherosclero-sis. Multiple factors can affect serum potassium levels including renal function, dietary intake, hormonal status, renin-angiotensin–aldosterone system, heart failure, myocardial infarction and drugs. The major limitation in the study conducted by Cavusoglu et al. [11] was that they only included subjects of the male gender. Diane et al. [24] previously reported that male sex was associated with higher potassium levels as compared to females. This could have clearly affected the results obtained by Cavusoglu and his research team.

In the second study conducted by Guang et al. [12] the study group has no patients with myocardial infarc-tion. Although studies have shown that in acute stress such as myocardial infarction, the potassium level is higher due to various mechanisms involving necrosis induced activation of aldosterone system and sympa-thetic-adrenal induced involvement of sodium-potassi-um pumps [25–27]. But by the exclusion of such group from the study also means that patients with more severe could not be assessed for the observed results.

We, in our study, not only included subjects of both genders but also myocardial infarction patients along with patients of chronic and stable coronary artery disease. We believe such a study group would a better understanding of patients in real-life situation. Moreover, we in our study not only assessed severity of coronary atherosclerosis not only by Gensini score which assesses the severity of coronary vasculature on the an-atomical basis and has been described elsewhere [19], but also SYNTAX score which is well-established sys-

tem for quantification of coronary lesions as well as for prediction of major adverse cardiac events (MACE) in patients undergoing percutaneous coronary interven-tion (PCI) [18, 28–30]. Such measures were taken in or-der to ensure more reliable and comprehensive results.

**Limitations**

It is a single centered study and was not designed to interpret results based on ethnicity and dietary habits. Selecting a large population with multi-centered study would address such concerns.

**Conclusion**

Serum potassium level is lower in coronary artery disease and is correlated with severity of atheroscle-rosis on coronary angiography. Serum potassium is an independent predictor of adverse outcomes in coronary artery disease patients.

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**Conflict of interest:**

None.

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Acta Angiol, 2020, Vol. 26, No. 2

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Introduction: The aim of this study is ter determine the outcomes following coronary endarterectomy (CE) in patients who underwent coronary artery bypass giafting (CAßG) for revasculatization in our hospitaI.

Methods: We retrospectively reviewed patients who underwent CABG over a six-month period, from November 1, 2016 to May 31, 2017 and examined their outcomes in regards to CE.

Results: A total of (n=361) CABG procedures were performed in our study period, though complete records were available for only (n=254) patients. Amongst these, (n=37) patients (14.ST) required CX. Ages ranged from 43 to 75 years for these patients, (n•7) were females and (n=30) males. Comorbidities included hypertension in (n=19) patients, diabetes in (n=12) patients and hepatitis B in (n=11) patients. The right coronary anery (RCA) was the most common artery endarterectomized (n= IS), followed by the left anterior descending (LAD) (n= 10), obtuse marginal (n• 6 patients), diagonals (n-5) and ramus (n•2). Two vessels were endarterectomized in (n=4) patients. A total of (n-9) patients had two-vessel CABG, (n=l6) had three-vessel CAßG and (n-8) had four-vessel CAßG. The leff internal mammary artery (LIMA) was used in (n=25) patients. Two patients required intra-aortic balloon purnp post-operatively. All the patients had received inDtropic support postoperatively in the intensive care unit (ICU). There were no reports of postoperative mortality. One patient remained in the ICU for four days postoperatively, the rest of the patients were stepped down to the ward in less than four days.

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Conclusions: CE is a safe and viable option as an adjunct to CABG in long segment totally occluded vessels needing revascularization and reconstruction.

Categories: Cardiac/Thoracic/Vascular Surgery, Cardiology, Internal Medicine

Keywords: revascularization, coronary endarterectomy, coronary artery bypass graft (cabg)



Coronary endarterectomy (CE) is a useful adjunct procedure generally done in the presence of diffuse coronary artery disease. It aims to restore uninterrupted blood flow by excising diseased

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segments as well as atheromatous deposits. it is a procedure necessitated in complicated cases



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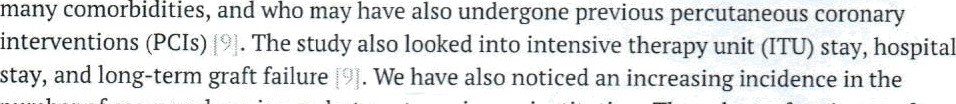
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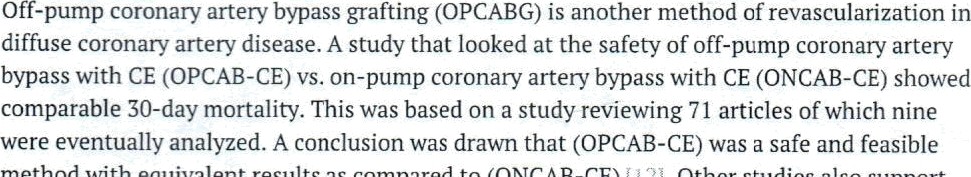
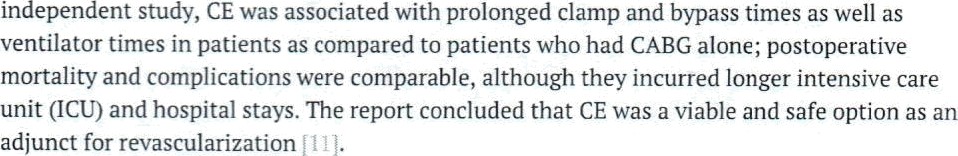
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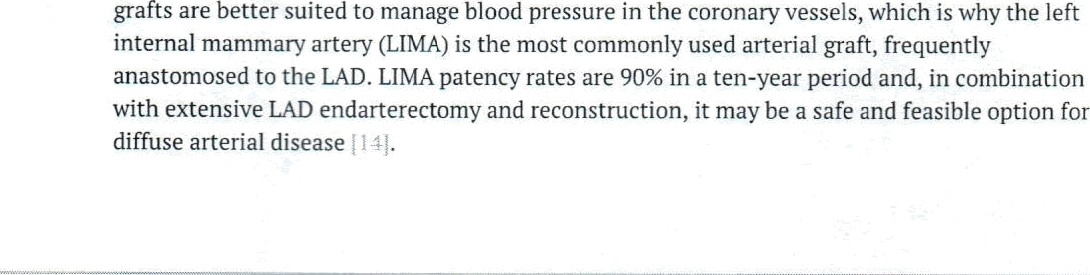


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Generally, cardiac surgeons prefer arterial grafts over venous in CABG procedures aS arterial

