OUTCOMES OF CORONARY ENDARTERECTOMY IN PATIENTS UNDERGOING CORONARY ARTERY BYPASS GRAFTING FOR CORONARY ARTERY DISEASE – A RETROSPECTIVE STUDY

Dr. JOSHI AAKASH DINESH

MCH CARDIOTHORACIC AND VASCULAR SURGERY THESIS

YEAR: 2020-2022

SREE CHITRA TIRUNAL INSTITUTE FOR MEDICAL SCIENCES AND TECHNOLOGY, TRIVANDRUM

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A THESIS SUBMITTED BY

Dr. JOSHI AAKASH DINESH

TO

SREE CHITRA TIRUNAL INSTITUTE FOR MEDICAL SCIENCES AND TECHNOLOGY, TRIVANDRUM

IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF MCH CARDIOTHORACIC AND VASCULAR SURGERY

YEAR: 2020 - 2022

DECLARATION BY STUDENT

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No part of the thesis has been submitted for the award or any other degree or diploma to this date

Date : 16/8/2022

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The thesis entitled "Outcomes of coronary endarterectomy in patients undergoing coronary artery bypass grafting for coronary artery disease -A retrospective Study ,was carried out under my direct supervision .No part of the thesis was submitted for the award of any degree or diploma prior to this date .

*Clearance was obtained from Institutional Ethics Committee /Institutional Animal Ethics/ Institutional Committee for stem cell research /other appropriate committees(if any ,specify),for carrying out of study .

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ACKNOWLEDGEMENT

Writing this thesis has been fascinating and extremely rewarding. I would like to thank a number of people who have contributed to the final result in many different ways.

An ostentatious use of words will not be sufficient to express my heartiest thanks to my guide Dr. Vivek V Pillai Professor, Department of Cardiovascular and Thoracic Surgery, SCTIMST, Thiruvananthapuram. His valuable and critical suggestions, constant inspiration and encouragement, instinctive corrective measures, timeless efforts, unstinted cooperation and mental support throughout have made this marathon task a smooth journey.

I will always remain obliged and grateful to my senior professor Dr. Jayakumar K and Professor & HOD Dr. Baiju S Dharan for his inspiration and support. I have to mention thanks to my Consultants Dr. Varghese T Paniker Dr. Sabarinath Menon, ,Dr Bineesh K R, Dr.Sudip Datta Baruah, Dr.Sowmya Remanan, Dr.Shivanesan Pitchai Dr. Renjith S and Dr Simon who has been instrumental and constantly supported me during the course.

I would like to express my gratitude to my Juniors Dr. Prithviraj Patil, Dr Rahul Sathessan, Dr Anshuman, Dr Hema Krishna, Dr Praveen, Dr Deepak, Dr Prithvi, Dr Zarin, Dr Sagar for their support throughout.

Sincere thanks to all other staff of the department of Cardiovascular and Thoracic surgery for their understanding, inspiration and affectionate encouragement right from the budding stage of this work.

I take this opportunity to thank my seniors, and my friends for their continuous help and support which gave strength to my thoughts and mapped my way to find methodology for myself.

Sometimes it is not easy to express in words especially when you have to say thanks to your parents for their constant undemanding love, dedication, sacrifice, Inspiring guidance, affectionate encouragement and never-ending enthusiasm, without which this study would not have seen the light of the day.

I would like to specially thank my wife Dr. Prachi Saxena and my parents for their constant support and care, encouragement and for being a pillar of strength throughout the duration of this study, without whom I would never been able to complete this endeavor.

My sincere gratitude to all patients who are the part of my study.

Last, but not the least, I thank the almighty God for being the silent force behind everything.

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SCTIMST

LIST OF ABBREVIATIONS

CE	-	Coronary endarterectomy
CABG	-	Coronary artery bypass grafting.
AR	-	Aortic Regurgitation
AV	-	Aortic Valve
DHCA	-	Deep hypothermic circulatory arrest
FC	-	Functional Class
LVEDD	-	Left ventricular End diastolic diameter
LVEF	-	Left ventricular Ejection fraction
LVESD	-	Left ventricular End systolic diameter
MODS	-	Multi organ Dysfunction Syndrome
NYHA	-	New York Heart Association
POD	-	Post operative day
SD	-	Standard Deviation
TCA	-	Total circulatory arrest
TEE	-	Trans Esophageal Echocardiography
PCI	-	Percutaneous coronary intervention
TA	-	Tranexamic acid
LAD	-	Left anterior descending artery
RCA	-	Right coronary artery
ITA	-	Internal Thoracic artery.

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SYNOPSIS

INTRODUCTION

Complete revascularization of coronary arteries, and mainly of the left anterior descending artery (LAD) which plays a significant role in terms of postoperative outcomes, is the primary objective in coronary artery bypass grafting (CABG). Nowadays, more and more patients having stenoses in one or two coronary vessels tend to be treated by percutaneous coronary intervention (PCI) [1]. As a result, diffuse coronary artery disease (CAD) is more likely among patients referred for CABG [2,3]. However, up to 25% of patients with diffuse CAD cannot be safely and successfully treated by standard CABG [4]. Therefore, several techniques including coronary endarterectomy, which involves the removal of the atherosclerotic core from the coronary artery lumen through an arteriotomy [5], have been proposed to expand surgical possibilities.

Baily et al. [6] were the first to describe coronary endarterectomy (CE) as a treatment against CAD without using CABG in 1957. However, its accompanying morbidity and mortality over shadowed its success in angina relief [7]. In particular, endarterectomy of the LAD was considered technically difficult8 and it initially appeared to be accompanied by high operative mortality and perioperative myocardial infarction[9]. Hence, coronary endarterectomy indications were restricted to those patients with diffuse coronary artery disease. Since that time, several publications have shown that coronary endarterectomy either with on-pump CABG 10 or with off-pump CABG can be safely performed [11] and is associated with favourable long-term outcomes [12]

Techniques

There are two different approaches to perform coronary endarterectomy: a closed and an open coronary endarterectomy: Nevertheless, it is not clear which is the optimal technique [13] There is a common point when these two approaches are compared. An arteriotomy of the coronary vessel to remove the atherosclerotic plaque is necessary in both of them [14] In the closed technique, a smaller arteriotomy is needed to remove the atherosclerotic plaque by applying gentle steady traction on it proximally. [15] Two concurrent arteriotomies can also be used for coronary endarterectomy to make the procedure faster and shorten ischemic time [16]. The closed technique is shorter and the anastomosis of the graft is easier 17, but occurrence of the snow plow effect – occlusion of the distal LAD and its side branches – due to insufficient endarterectomy is more possible [18]. Despite gentle traction applied on the proximal part of the atheromatous core in LAD, its distal part in diagonal branches and septal perforators may be torn off forming an intimal flap. As a result, occlusion of the lumen may occur distally due to a thrombus or dissection[19].

OBJECTIVES

Primary objective:

1 To Study ten-year survival for patients undergoing coronary endarterectomy in patients with coronary artery disease

Secondary Objective:

2. To determine any major adverse cardiac and cerebrovascular events in patients undergoing coronary endarterectomy with coronary artery bypass grafting

RESULT

Patient Selection

Total of 62 patients underwent coronary artery bypass grafting with coronary endarterectomy and were included in the study. 61 patients were elective and 1 patient was taken up as an Emergency procedure. Out of 62 patients, 57(91.9%) patients were males and 5 patients (8.1%) were females. Mean age was 68.5 +/-10 years. Most common risk factor associated in our

study with coronary artery disease was diabetes, present in 40 patients (64.5%), Hypertension in 32 patients (37.1%),21 patients have history of smoking (33.9%), and 15 patients were dyslipidaemia (24.2%).
Majority of the patients 64.5 % who underwent coronary endarterectomy were diabetic. Out of 62 patients, 61 no of patients (96.8%) had triple vessel disease and only 1 patient (1.6%) had double vessel disease. There was an improvement in the functional status post operatively and it was statistically significant. Mean pre operative EF was (61+/-10.6) and mean postoperative EF was 63.7+/-10.7. There was improvement in the postoperative EF compared to pre operative EF and the difference was statistically significant. Out of 62 patients, 61 patients underwent surgery using cardiopulmonary bypass (98.4%) and one patient underwent OPCABG (1.6%). More than half of patients (32 patients) had four number of grafts (51.6%), followed by five grafts in 17 patients (27.4) % and three grafts in 10 patients (16.1 %) and six graft in 2 patients (3.2 %). The mean cross clamp time was 73.3 ±31.8 minutes, and cardiopulmonary bypass time was 119 ± 40.9 minutes. Mean Ventilation time was 15 ±2.9 hours. Mean Hospital stay was 10.5 ±4.8 days and mean ICU stay was 5.3 ±2.9 days. The most common vessel to undergo endarterectomy was RCA ,31 patients (50%).Endarterectomy of LAD was done in 15 (24.2%) patients ,PDA artery was done in 7 patients (11.3%),followed by OM-2 four patients (6.5%),OM-1 in 2 patients (3.2%),OM -3 in 1 patietns (1.6%)

Total mortality was 5 patients (8.06%). In hospital mortality was 1(1.6%) due to multi-organ dysfunction following low cardiac output. The estimated 1year survival is 98.45%, 5 year survival was 96.5% and 10-year survival was 89.9 %. Two patients had stroke; another two patients had acute myocardial infarction after 2 years of surgery for which PCI was done. There were no re-operations. We didn't find any correlation between any of the variables studied and the mortality.

CONCLUSION

In the recent decades, the treatment of older patients with diffuse CAD, alongside multiple comorbidities and high expectations for successful treatment, has become a real challenge. CE is a surgical method that can provide acceptably effective and safe results in the treatment of CAD. CE as an adjunct to CABG, has a significant role in achieving adequate revascularisation and in improvement of long-term outcomes. In our study the survival rate at 1 year, 5 year and 10 year were 98.4%,96.5% and 81.4% respectively.

INTRODUCTION

Complete revascularization of coronary arteries, and mainly of the left anterior descending artery (LAD) which plays a significant role in terms of postoperative outcomes, is the primary objective in coronary artery bypass grafting (CABG). Nowadays, more and more patients having stenoses in one or two coronary vessels tend to be treated by percutaneous coronary intervention (PCI) [1]. As a result, diffuse coronary artery disease (CAD) is more likely among patients referred for CABG [2,3]. However, up to 25% of patients with diffuse CAD cannot be safely and successfully treated by standard CABG [4]. Therefore, several techniques including coronary endarterectomy, which involves the removal of the atherosclerotic core from the coronary artery lumen through an arteriotomy [5], have been proposed to expand surgical possibilities.

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Techniques

There are two different approaches to perform coronary endarterectomy: a closed and an open coronary endarterectomy: Nevertheless, it is not clear which is the optimal technique [13] There is a common point when these two approaches are compared. An arteriotomy of the coronary vessel to remove the atherosclerotic plaque is necessary in both of them [14] In the closed technique, a smaller arteriotomy is needed to remove the atherosclerotic plaque by applying gentle steady traction on it proximally. [15] Two concurrent arteriotomies can also be used for coronary endarterectomy to make the procedure faster and shorten ischemic time [16]. The closed technique is shorter and the

anastomosis of the graft is easier [17], but occurrence of the snow plow effect – occlusion of the distal LAD and its side branches – due to insufficient endarterectomy is more possible [18]. Despite gentle traction applied on the proximal part of the atheromatous core in LAD, its distal part in diagonal branches and septal perforators may be torn off forming an intimal flap. As a result, occlusion of the lumen may occur distally due to a thrombus or dissection[19].

On the contrary, when the open approach is applied, a longitudinal arteriotomy is performed on the coronary vessel beyond the limits of the atheromatous plaque and the atherosclerotic plaque is lifted off [20]. Then, an on-lay patch anastomosis to the LAD derived from the internal thoracic artery or saphenous vein graft, which is opened to the appropriate length, is performed[21]. Alternatively, a longitudinally opened saphenous vein patch can be sewn in place of the arteriotomy and then the left internal thoracic graft can be anastomosed entirely to the vein patch [22]. Although this method takes more time, the atheromatous plaque is removed under direct vision, so the openings of the side branches and of the distal end of the LAD can be directly checked. Moreover, if a dissection of the intima of the distal LAD happens, it can be fixed to secure the distal flow. [23]

Consequently, although the open technique takes more time [24] it prevents intimal flap formation and therefore avoids residual obstruction [25] Therefore, provided that the open technique is used, the quality is guaranteed [26]. According to the results of Nishi's study[27], comparing the open method with the closed one, open endarterectomy is superior to the latter. Patients who underwent open endarterectomy had a lower, although non-significant perioperative mortality. However, this group was associated with statistically significantly better long- term results. The five-year survival rate was 90.7% in the group of open endarterectomy, whereas it was 74% for the group of the closed technique. Moreover, the open method was also associated with better results in terms of morbidity, as 85.2% of patients openly endarterectomized compared to 76.6% of patients endarterectomized with the closed method suffered neither from angina nor from congestive heart failure during the follow-up [28]. Therefore, it can be assumed that although time-consuming, the open approach is the best method of endarterectomy.

OBJECTIVES

Primary objective:

1. To Study ten-year survival for patients undergoing coronary endarterectomyin patients with coronary artery disease

Secondary Objective:

2. To determine any major adverse cardiac and cerebrovascular events in patients undergoing coronary endarterectomy with coronary artery bypass grafting.

REVIEW OF LITERATURE

CE is a surgical procedure performed alongside CABG for the treatment of diffuse CAD. It involves an arteriotomy of the coronary artery and the excision of the atheromatous plaque occluding the vessel in order to revascularize the ischaemic myocardium. Charles Bailey was the first to successfully perform the procedure on two patients at Hahnemann Hospital in Philadelphia, USA, in October 1956.

Recently cardiac surgeons are facing increasingly complex CABG due to increased comorbid conditions including diabetes mellitus, renal insufficiency, peripheral vascular disease and previous interventions for coronary disease [29] which often requires endarterectomy.

CE is being performed in all the centres with acceptable results. CE has shown to benefit patients with advanced coronary atheroma by providing complete revascularization as shown by Bailey in late 1950's [30]. The safety and long-term efficacy of the procedure, although controversial, has been demonstrated in both past and recent studies. [31]

The main indication for CE is the presence of diffusely diseased coronary arteries that are not suited for distal grafting [32]. Although CE has been performed on all coronary arteries safely, there are some evidences which suggest that endarterectomy of the Left Anterior Descending (LAD) coronary artery may be particularly hazardous [33]. Most surgeons, therefore, perform LAD endarterectomy in a highly selective manner when no other alternatives exist [34]. The LAD atherosclerotic plaque is hard and frail as compared to Right Coronary Artery (RCA), thereby increasing the risk of disruption. The diagonal and septal branches that arise from LAD in two different planes have the risk of shearing-off of branches when plaque is pulled in either direction [35]. Open CE is done when plaque extraction is incomplete through a limited arteriotomy or when the plaque is fractured. The open technique is preferred in such circumstances which provide an adequate exposure to excerpt the atherosclerotic core. The basic principle of coronary endarterectomy is to extract the plaque completely.

Anticoagulation therapy that plays a crucial role in preventing postoperative myocardial infraction (MI) in a case of CE, though not uniform, has been less aggressive.

Unlike the coronary endarterectomy performed in 50's, the paradigm under which cardiac surgery is performed has changed in terms of use of cardiopulmonary bypass, availability of superior drugs and techniques along with the growing experience of the surgeon. This has led to a point in which feared procedures like CE could be performed more safely under different circumstances. Today's conditions are much better than starter time and CE cannot be abandoned considering the frequent points of criticism. Therefore, focus on current results is needed.

Off versus on pump CABG: CE is a technically challenging procedure even when Cardio Pulmonary Bypass (CPB) is used. Inexperienced surgeons avoid performing CE because of the unavoidable CPB related inflammation, global ischemia and incomplete revascularization [36]. Off-pump coronary artery endarterectomy is considered by many surgeons as the technique of choice, especially in high-risk patients[37].

Open vs closed CE: Coronary endarterectomy can be performed by either closed or an open technique. The closed technique involves a small arteriotomy with gentle steady traction on the atheromatous plaque until it comes out from the native artery proximally and distally. It is not possible to prevent intimal flaps and possible residual obstruction with this technique [38]. Open technique CE is performed by opening native artery longitudinally beyond the limits of the endarterectomy which allows the plaque to be carefully lifted off under direct vision and the edges to be fixed. Later, patch closure of the LAD is done followed by bypass grafting [39]. With this technique, complete relief of obstruction is assured and intimal flaps are prevented.

Author	Study type	Patient group	Outcome studied	Key results for CABG and CE	Comments
Tiruvoipati R et al.,	A retrospective study design	Patients who had CABG between January 1995 and December 2001 were included. They were divided into two groups, 5782 patients in CABG-only group and 461 patients in CABG and CE group.	Perioperative myocardial infarction, postoperative ventricular arrhythmias, cerebrovascular accident, renal impairment, and early mortality.	Myocardial infarction: 7 (1.5%) Ventricular Arrhythmias: 14 (3%) Stroke: 8 (1.7%) Renal impairment: 34 (7.4%) Mortality: 40 (8.6%)	Coronary endarterectomy when combined with CABG seemed to be associated with a higher mortality than isolated CABG in our study groups, but this is related to comorbidities of these patients rather than the CE.
Sirivella S et al.,	A prospective study design	Study done during 1985 to July 2002, 8,874 patients who underwent isolated myocardial revascularization procedures, 1,478 patients underwent CE with CABG for diffuse coronary artery disease consecutively. Patients in the CE group were of higher risk with increased rate of co morbidities and triple-vessel coronary disease.	Postoperative comorbidity and mortality, five and 10 year survival, angina and NYHA class	The operative mortality (3.2% versus control 2.2%; p-value=0.03) and the incidence of major postoperative morbidity (not significant) were comparable between the groups. At long-term follow-up, five year and 10 year survivals were 83±5% and 74±3% respectively and alleviate from angina at five and 10 years was 75±5% and 69±4% respectively with 96% of survivors in New York Heart Association class II.	In selected patients with diffuse coronary artery disease, coronary endarterectomy can be used as a tool for myocardial revascularization. The operative mortality and major morbidity were comparable or similar to coronary artery bypass grafting, and short-term and long-term results were favourable.
LaPar DJ et al.,	A retrospective study design	Patients undergoing isolated CABG operations from 2003 to 2008 were retrospectively reviewed where 99 patients underwent CE and 3:1 propensity matched them to 297 CABG-alone patients, based upon clinical factors.	Operative mortality, ICU stay, hospital stays, long-term mortality, MI.	Operative mortality was 4.0%, ICU stay was 75.06 hrs and hospital stays were 9.01days.	Patients undergoing CABG with coronary CE required longer ventilator support and ICU stay. Yet have comparable operative mortality, major complication rates, and long-term survival to isolated CABG.
Ariya P et a	Retrospective study design	The study involves retrospective analysis of data collected prospectively on 801 patients undergoing CEs between February 1988 and September 2010 by a single surgeon using a standard open hydrodissection technique.	Operative mortality and median survival time.	The operative mortality was 2.62%. The median survival time was 16.67 years.	Significant long-term survival demonstrates that CE can be an attractive adjunct to CABG in otherwise inoperable coronary artery disease.
Schmitto JD et al.,	Prospective study Design	Between August 2001 and March 2005, 104 patients underwent coronary artery bypass grafting CABG with adjunctive CE in the Department of Thoracic, Cardiac and Vascular Surgery, University of Goettingen.	Number of vessels endarterectomised, open or closed technique, operative mortality, long term survival, symptom improvement.	CE was performed on RCA (n = 55), on LAD (n = 52) and Circumflex artery (RCX) (n = 7). Closed technique was used in 18%, open technique in 79% and in 3% a combination of both. Only 5% follow-up for 24.5±13.4 months and survival rate 92% NYHA-classification significantly improved after CABG with CE from 2.2±0.9 preoperative to 1.7±0.9 postoperative	Early results of CE are acceptable with respect to mortality, NYHA and CCS. This technique offers a valuable surgical option for patients with end stage coronary artery disease in whom complete revascularization otherwise cannot be obtained.
Vohra HA et al.,	A prospective study design	680 patients underwent OPCAB with adjunctive CE in 70 patients.	CE in OPCAB	18 patients (35%) had impaired left ventricular function. There were no conversions to cardiopulmonary bypass. Three patients (4.3%) suffered from postoperative myocardial infarction, and three patients required postoperative IABP counter pulsation.	The study concluded that OPCAB surgery with CE is feasible and in patients with diffuse coronary artery disease the surgical revascularization is achieved successfully.

Table 1: Articles on coronary endarterectomy

Role of arterial versus vein conduits: With increasing experience of total arterial grafting in CABG, surgeons have started using arterial conduits for endarterectomised vessels [40]. There is paucity in evidence regarding the role of arterial grafts in endarterectomised vessels in relation to late survival and graft patency.

Schwann TA et al., reviewed their 288 CABG-CE patients (mean age 63±10 years) of which men were 207. A total of 1,056 grafts {275 ITA (26%); 221 radial (21%), 560 vein (53%)} were used. Total 325 (31%) conduits were placed to CE targets. Perioperative mortality occurred in 18 (6.3%) patients. The one and five-year survival for the 270 discharged patients was 95.2% and 83.0%, respectively. Survival was superior for patients with radial (n=154) versus no-radial (n=134) artery grafting (p-value=0.021). Multivariate Cox regression analysis associated with increased number of arterial grafts {Hazard Ratio (HR)=0.64 (0.44 to 0.92)}; HR (95% confidence interval) to improved survival, whereas RCA endarterectomy (HR=1.8, 1.0, 3.3; p-value=0.054) was associated with worse survival. Repeat angiography was done in 68 patients comprising 78 CE (38 vein, 24 ITA, and 16 radial) and 162 non-CE (84 veins, 40 ITA, and 38 radial) grafts. For CE targets, graft failure was worse for vein (55% vs 35%; p-value=0.05) and unchanged for arterial (13% vs 15%; p-value=0.88) grafts. Authors concluded that combined CABG/ CE is associated with acceptable long-term outcomes. Increased arterial grafting achieved by radial artery utilization offers a survival benefit in high-risk population.

Single vs double vessel endarterectomy: Results of single vessel LAD endarterectomy are better than multiple vessel endarterectomies [41]. The reason being good visualization of LAD along the majority of its course, minimum hemodynamic disturbance in off-pump procedures. The option of on lay patch grafting using mammary artery is almost limited to LAD.

In a retrospective study on single vessel CE by Takahashi M et al., constituting 12 patients (Age: 72±4 years) the mean numbers of diseased coronaries were 3±0.4, and the mean numbers of grafts performed were 4±0.8 [42]. One patient was converted from off- pump to on-pump. The mean intensive care unit stay and the mean hospital length of stay was 3±2.8 and 15±13 days respectively. Postoperative follow-up (mean 24±19 months) was complete, and no ischaemic events were seen in early and mid-

term follow-up. The study concluded that off-pump endarterectomy of the LAD is a viable option for patients with diffuse LAD disease.

Marzban M et al., in their four yearlong retrospective study, analysed 310 patients (3.28%) who underwent concomitant coronary artery endarterectomy, 39 of whom (12.6%) required double vessel endarterectomy (Group 2) and the rest of whom required single endarterectomy (Group 1) [43]. Variables of these groups were compared by means of univariate analysis. Group 1 consisted of 76.3% men and mean age of the patients was 58.73±9.36 year. Perioperative MI reported in 13% and 15.4% patients in Group 1and 2 respectively. In Group 1, the early mortality rate was 3.3% compared to 10.3% in Group 2 (p-value <0.05). In multivariate analysis of endarterectomised arteries, the combinations of vessels most strongly associated with mortality were LAD or Diagonal along with RCA. There was no association between endarterectomy of particular vessels and perioperative myocardial infarction. The study concluded that addition of second endarterectomy worsens the prognosis dramatically.

Endarterectomy in combined coronary and valvular surgery:

Literature analysing effects of CE in combined procedures is lacking although available report supports it. Kumar S et al., in their 14 year retrospective study on 237 patients who underwent CABG with valve surgery, 41 patients needed CE. The intensive therapy unit stay was less than 48 hours after surgery in 32 patients. Six mortalities occurred during the 14 year follow up with ten year survival of 57.2% (95% CL, 37.8%–86.6%). None required further percutaneous or surgical intervention. Authors inferred that CE does not add to the overall mortality incidence in combined procedures [44].

Postoperative anticoagulation regimen: At present there is no unified guideline available regarding the use of antiplatelet or anticoagulation therapy in patients undergoing CE. Though most of the authors have followed different anticoagulation regimen as per their institute protocols, the overall reported difference in bleeding and mortality remains clinically insignificant.

Use of an antifibrinolytic agent: Early graft occlusion is the concern with perioperative antifibrinolytic therapy. Ruel MA et al., studied 221 patients who underwent CABG with CE of the RCA alone in 149, the LAD in 35, or both right and left anterior descending in 27 [45]. Tranexamic Acid (TA) was given intraoperatively in 87 patients (TA group: average total dose 62±4.4 mg/kg), and was not used in 134 patients (No TA group). The patient risk distribution was similar in both the groups. The perioperative MI rate was 2% and 5% in the TA and No TA groups, respectively (p-value=0.49). Patients in the TA group had a significant reduction in postoperative chest tube drainage and in the use of fresh-frozen plasma (p-value=0.03).

Authors concluded that the use of tranexamic acid in patients undergoing coronary endarterectomy is not associated with a higher incidence of MI-related complications.

Authors	Anticoagulation Regimen
LaPar DJ et al.,	Dual antiplatelet therapy for at least 3 months. Postoperative myocardial infarction - 1%. Operative mortality - 4%.
Schmitto JD et al.,	Heparin infusion four hours postoperatively if the bleeding ≤50 ml/ hr. 100 mg of aspirin were given daily, starting at the first postoperative day. In hospital mortality - 5%.
Marzban M et al.,	Reverse the heparin completely at the end of the operation Start heparin six hours later in the ICU if bleeding ≤100 ml/hr Warfarin: 2-3 months (INR: 2.5-3.5). Hospital mortality - 5%.
Kumar S et al.,	300 mg of aspirin per rectally six hours after the procedure. Combination of aspirin and clopidogrel 75 mg each daily from the first postoperative day. Clopidogrel for six months postoperatively and aspirin lifelong. Patients in atrial fibrillation and/or mechanical valves are anticoagulated with warfarin and aspirin. Reported mortality - 9.8%.

Table 2: Anticoagulation regimes.

At present the available evidence supports CE in off-pump CABG. Long term patency of the graft is better with open technique however the 5-year survival remains the same for both open and closed methods. Multi-vessel CE increases the overall morbidity and mortality. Use of arterial conduits especially radial grafts is associated with better long-term outcome in high risk patients. Adjuvant CE in valvular

procedures do not affect the overall outcome. Postoperative anticoagulation regimen is not uniform at present and initial report supports use of antifibrinolytic therapy in postoperative period.

Indications

Although the efficiency of coronary endarterectomy is doubted [46] it constitutes an additional treatment in cases of diffuse CAD and severe calcification of coronary arteries [47] In cases of diffuse CAD, affected side branches (diagonal and septal branches) obtain sufficient blood flow when endarterectomy is efficiently performed. However, conventional CABG with a distal anastomosis to LAD itself is not sufficient to supply blood to side branches and residual angina is possible. Moreover, neither intense calcification nor soft atherosclerotic plaques are contraindications to obtain a satisfying anastomosis after coronary endarterectomy [48]. On the contrary, if a simple anastomosis was performed in the latter case, plaque rupture resulting in emboli formation would be possible [49]. Therefore, coronary endarterectomy has evidence when diffuse atherosclerosis affecting side branches exists [50] and when severe calcifications of the LAD prevent the performance of a simple anastomosis of the left internal thoracic artery graft to the LAD[51]. Preoperative coronary angiographic findings such as luminal diameters smaller than 1mm [52], obstruction and pinching of the side branches in multiple sites, and an uneven and diffuse thread-like appearance can constitute indications for endarterectomy[53]. However, the final decision to perform endarterectomy is made intraoperatively when the a forementioned findings are noted [54].

Anticoagulation protocol

After coronary endarterectomy, the lack of the endothelium leads to coagulation cascade activation by the subendothelial material exposed to blood flow [55] Therefore, strict antiplatelet and anticoagulation management is required [56] However, no standard anticoagulation protocol after coronary endarterectomy exists [57] Heparin infusions followed by warfarin for several months are recommended by several authors [58]. Postoperatively, intravenous heparin, 100mg of aspirin per day, and warfarin are administered. The systematic administration of heparin is continued until warfarin is effective (meaning an international normalized ratio between 2.0 and 2.5).

After 3 months, warfarin is also discontinued for aspirin [59]. A preoperative or intraoperative dose of clopidogrel followed by postoperative aspirin and clopidogrel administration is another anticoagulation scheme used after coronary endarterectomy[60].

Safety of coronary endarterectomy

Residual disease due to incomplete revascularization is associated with high operative and late mortality after CABG. Perioperative and late myocardial infarction rates and reoperation rates are also increased after incomplete revascularization. Moreover, when revascularization is incomplete, symptoms are not completely relieved and there is an adverse impact on left ventricular functional reserve. All these deleterious effects of incomplete revascularization on survival are more intense when the LAD is incompletely revascularized [61]. Coronary endarterectomy, particularly of the LAD, can successfully be performed with diffuse CAD [62], as it can achieve complete revascularization and prevent all the aforementioned deleterious effects [63].

Although endarterectomy has been described to multiple vessels, single-LAD endarterectomy is preferred as LAD can be easily visible along nearly all its length, its adequate stabilization is easier, and less displacement of the heart is needed to reveal it during off-pump CABG [64]. However, excellent short-term clinical and angiographic results accompany right coronary artery (RCA) endarterectomy according to Erdil et al. [64]. Moreover, no additional morbidity or mortality is associated with RCA endarterectomy when compared to non-endarterectomized RCAs during RCA bypass [65]. But is coronary endarterectomy a safe procedure?

Overall, hospital mortality rate ranges from 2.0% to 6.5% in international literature [66]However, the mortality after CABG along with endarterectomy appears to be higher compared to that after conventional CABG because of the associated comorbidities and risk factors rather than the endarterectomy itself. Furthermore, perioperative myocardial infarction, which is one of the most severe problems during coronary endarterectomy, is limited to 1.5–8% of patients [67] Finally, late graft patency rates after coronary endarterectomy range from 40% to 81.5% [68] However, single endarterectomy is safer than double endarterectomy [69] When the RCA is endarterectomized in addition to the LAD or a diagonal branch is endarterectomized

in addition to the RCA, early mortality is increased. Postoperative myocardial infarction is also increased when a second coronary vessel is endarterectomized, no matter which coronary vessel is involved [70].

Among 12 patients who underwent off-pump endarterectomy, included in Takahashi et al.'s [71] study, hospital mortality was zero. Conversion to on-pump CABG was required in one patient whose LAD could not be stabilized adequately. Red blood cell transfusion was necessary in eight patients (67%). Postoperative morbidity was minor including no postoperative and perioperative myocardial infarctions and strokes, two cases requiring reoperation due to bleeding, two cases with transient postoperative atrial fibrillation, and one case with respiratory failure requiring a tracheostomy. The intensive care unit stay was prolonged provided that all of the patients suffered from diffuse CAD. Postoperative follow-up (mean 24±19 months; range 1–53 months) revealed neither early nor mid-term ischemic events [72] .In the Department of Thoracic, Cardiac and Vascular Surgery of Goettingen University in Germany, coronary endarterectomy combined with CABG was performed in 104 patients in about four years [73] .The procedure was performed only in cases with occluded, nearly occluded, or calcified vessels, the anastomosis of which was technically impossible. One hundred patients received complete follow-up (24.5 ± 13.4 months).

Coronary endarterectomy was performed on RCA in 55 patients, on LAD in 52 patients, and on circumflex artery in 7 patients. Hospital mortality was 5%. There were 3 myocardial infarctions during operation time, 18 bronchopulmonary complications, 3 patients suffering from sternal infection, and 2 patients with sepsis. The overall infection rate was 18%. During follow- up, eight patients died (three due to cardiac failure, one due to stroke, one due to cancer, and three because of unknown reasons). Finally, both New York Heart Association (NYHA) and Canadian Cardiovascular Society (CCS) classifications clearly improved after the implementation of CABG with coronary endarterectomy [74]. Another study included 148 patients who underwent coronary endarterectomy of the LAD at the Shin-Tokyo Hospital and the Sakakibara Heart Institute between April 2001 and March 2008 [75]. Off-pump CABG was performed in 81.8% of them. Mortality rate was 2.7% (n=4). Morbidity rates were also acceptable, including low cardiac output syndrome in 9 patients (6.1%), 18 postoperative myocardial infarctions (12.2%), 10 cases of

respiratory failure (6.8%), re-exploration for bleeding in 5 patients (3.4%), 4 strokes (2.7%), 5 patients who required Hemo-dialysis (3.4%), 5 cases of mediastinitis (3.4%), and 38 cases of atrial fibrillation (25.7%). Early postoperative angiography revealed complete patency of both the left internal mammary artery and LAD in 94.0% of the 134 patients who underwent angiography. One of the remaining eight patients with anastomosis failure suffered perioperative myocardial infarction, but the mortality was zero. Comparing preoperative with postoperative left ventricular ejection fraction in 139 patients (93.9%) revealed no significant difference [76] Fundaro et al. studying 13 patients who underwent an open LAD endarterectomy and 5 patients who underwent an open right coronary artery endarterectomy observed no early or late postoperative mortality. No adverse postoperative events were noted either, apart from a perioperative myocardial infarction, but not in the area of the endarterectomized vessel. Angiographic assessment between the 9th and the 15th postoperative day in 16 patients showed one closed graft after LAD endarterectomy. Follow-up, ranging from 3 to 15 months, showed complete angina relief in all but the last mentioned patient .

In another study including 37 patients who underwent LAD endarterectomy, a 2.7% operative mortality rate (n = 1) and one case of perioperative myocardial infarction were observed [77]. In another group including 61 patients who underwent right coronary artery endarterectomy, a 3.3% operative mortality rate and a 4.9% perioperative infarction rate were observed. Follow-up (14–55 months) revealed one patient's death whose preoperative ejection fraction was 27%. The patient died five months after CABG due to congestive cardiomyopathy. Two cases of anterior wall myocardial infarctions at 10 and 16 months after operation were also observed. On the contrary, anterior segmental and global left ventricular functional reserves were intact 20 months postoperatively in all the remaining 35 patients, suggesting patent grafts and endarterectomized LAD arteries [78]. Finally, 127 patients with diffuse CAD underwent CABG with coronary endarterectomy between January 1994 and April 2003 at Osaka City General Hospital [79].

This study recommended that coronary endarterectomy is related to an acceptable operative risk as six deaths (4.7%) were noted, whereas four patients (3%) suffered a perioperative myocardial infarction. Infection was observed in six cases, six patients

required re-exploration for bleeding, and only two patients suffered a cerebral vascular accident. Moreover, intraaortic balloon pump was necessary in 21 patients (17%) and 20 late deaths occurred [80]

Table 3 :outcomes of coronary endarterectomy

Postoperative outcomes after coronary endarterectomy.

Study	Number of patients	Number of target coronary lesions	Early mortality	Peri-operative myocardial infarction	Follow-up		Angiographic graft patency	
					Completion rate	Results	Completion rate	Patency rate
Takahashi et al.	12	12 LAD	0	0	100% (24 ± 19 months)	No ischemic events	2 patients (17%)	100 %
Schmitto et	104	52 LAD, 55 RCA, 57 LCx	% (n = 5)	2.9% (n = 3)	96% (24.5 ± 13.4 months)	8 deaths, improved NYHA, improved CCS	-	-
Takanashi e	148	148 LAD	2.7% (n = 4)	12.2% (n = 18)	-	-	134 patients (91.2%)	94 %
Fundarò et	18	13 LAD, 5 RCA	0	5.6% (n = 1)	100% (3–15 months)	No late deaths, 1 residual angina	16 patients (89%)	94 %
Shapira et a	37	37 LAD, 10 RCA	2.7% (n = 1)	2.7% (n = 1)	100% (14–55 months)	1 death, 2 myocardial infarctions	-	-
Nishi et al.	127	71 LAD, 53 RCA, 17 LCx, 7 diagonal arteries	4.7% (n = 6)	3% (n = 4)	97.6% (52 ± 31 months)	20 late deaths	Early (115 patients (91%)) Mid-term (12–66 months: 78 patients (61.4%))	90.2% (excellent 73.7%) 85.2% (excellent 58%)

LAD, left anterior descending artery; RCA, right coronary artery; LCx, left circumflex artery; NYHA, New York Heart Association; CCS, Canadian Cardiovascular Society.

Coronary artery bypass grafting (CABG) is the standard of treatment of patients with complex coronary artery disease (CAD) and aims to the complete myocardial revascularisation [81]. Particular attention is drawn to the adequate revascularisation of the left anterior descending artery (LAD), as it predominantly affects the postoperative and long-term outcomes [82].

During the last years, because of the knowledge of the pathophysiology of CAD and improvement in experience and technology, the percutaneous coronary interventions (PCIs) are the first line treatment in patients with focal or localised CAD [83]. Patients with diffuse, multi-vessel and extensive CAD with impaired left ventricular function are more commonly treated with CABG [83]. However, up to 25% of these patients with complex disease cannot be successfully and safely grafted, and are thus considered inoperable[84]. In addition, elderly patients with multiple comorbidities, having undergone previous PCIs, increasingly present with severe and diffuse atherosclerotic disease, which also confer a high operative risk and poor postoperative outcomes [85].In view of the above, and in an effort to improve the success rate and safety of CABG, the role of Coronary Endarterectomy (CE) has been reassessed [86]. CE is a surgical procedure performed alongside CABG for the treatment of diffuse CAD. It involves an arteriotomy of the coronary artery and the excision of the atheromatous plaque occluding the vessel in order to revascularize the ischaemic myocardium.

History of CE

CE is one of the first surgical procedures for the treatment of severe atherosclerosis and myocardial ischaemia, as it has been used for over 55 years [87] .Charles Bailey was the first to successfully perform the procedure on two patients at Hahnemann Hospital in Philadelphia, USA, in October 1956 [88] Initially, CE was performed using a distal, blind, retrograde technique without heart-lung bypass; it was also a lone procedure, as CABG was not developed until the 1960s [89] Two years later in 1958, Longmire and colleagues performed antegrade endarterectomy under direct vision, i.e. using the open technique (for the first time [90].

However, the benefit of CE on angina relief was quickly over- shadowed by the observation that it was associated with high perioperative MI [91], postoperative morbidity and mortality rates[92].

For historical reasons, it is worth mentioning that apart from the usage of the surgical instruments for the conduction of the endarterectomy, an alternative technique using carbon dioxide gas was introduced by Sawyer in October 1965 [93]. Two reliable case series by the teams of Klie et al. (1974) and Yacoub et al. (1975) both published in Circulation, using the gas technique had shown encouraging results

In addition, other techniques such as laser, cardioplegia infusion and even a 'modified battery-powered toothbrush' have been used to separate the atheroma from the vessel wall [94]. However, in the following years, the classic surgical technique became the preferred method and was performed in a highly selective group of patients. Nonetheless, its use became quite sporadic due to the significant rates of associated morbidity and mortality [95].

In view of patients with increasingly complex presentations in the recent years, CE has been brought back into clinical practice. The procedure is currently used as an adjunct to on-pump or off- pump CABG with comparable results between these two procedures[96].

In our era, the cardiac surgeons prefer to endarterectomise the LAD, even though the RCA was the main target in the early years because of less devastating thrombotic complications at the time [97].

CE is a valuable surgical tool in the face of diffuse CAD when complete revascularisation cannot be otherwise obtained. It is accompanied by good angiographic patency rates and with acceptable morbidity and mortality rates regardless of the coronary vessel endarterectomised. Nevertheless, this technique is not appropriate for all CAD patients and should only be performed by experienced surgeons, as it is technically demanding[98].

Open versus closed technique

There are two main techniques, namely open and closed, that can be used to perform the procedure [99]. The open technique involves a large longitudinal arteriotomy of the coronary artery beyond the limits of the stenosis, and the atherosclerotic plaque being lifted off under direct vision [100] Then, an on-lay patch anastomosis to the LAD derived from the internal thoracic artery (ITA) or a saphenous vein graft (SVG) opened at the appropriate length, is performed [101] The open technique is more time-consuming than the closed one, but it involves a lower likelihood of intimal flap

formation and consequently, the residual obstruction, dissection and distal myocardial ischaemia are avoided [102].

The closed technique involves a smaller arteriotomy to remove the atherosclerotic plaque by applying steady, gentle traction on the plaque proximally and distally [103]. Two concurrent arteriotomies can be used to make the procedure quicker and to shorten the ischaemic time. The closed technique is quicker and performing the graft anastomosis is easier [104]. However, there are some safety concerns that need to be taken into consideration. There is an increased likelihood of the occurrence of the snowplow effect, i.e., occlusion of the distal LAD and its side branches due to insufficient endarterectomy [105]. Furthermore, despite gentle traction being applied to the proximal part of the atheromatous core of the LAD, the diagonal branches and the septal perforators may be torn off forming an intimal flap. This in turn can result in the occlusion of the lumen distally due to thrombus formation or dissection [106].

Even though it is not entirely clear so far which is the optimal technique, the open technique appears to be a safer option [107].

Despite the promising nature of CE, there has been controversy around the safety of the procedure, particularly when the LAD is involved, due to the high associated morbidity and mortality[108]. A major concern is the probability of postoperative MI, following embolization of atheromatous debris or de novo thrombogenesis, due to the destruction of the endothelium [109]. As a result, some centres only perform the procedure in a highly selected group of patients and when no alternative exists, while others do not perform it at all [110].

The early studies: 1970 to 1989

The first case series of patients with CEs were published in 1970s.

In 1975, Cheanvechai and colleagues presented the midterm outcomes of 315 patients who underwent CE adjunct to SVG CABG. The in-hospital mortality rate was 1.27%, the perioperative MI incidence was 4.8%, and the patency rate was 76.3% (average follow-up 13.1 months; angiography in 186 vessels) [111].

In 1985, Qureshi et al., studied 278 patients who had CABG with concomitant CE (early and late mortality was 4% and 10% respectively and perioperative MI was 12%). The early patency rate was 83% (LAD) and 75% (circumflex) and 75% at one year (75 patients) [112].

Brenowitz et al., in 1988, investigated the outcomes of 5005 patients who underwent CABG alone (group A; 50%), or in combination with single CE (group B; 25.1%), or multiple CEs (group C; 24.9%). Operative mortality was 4.0% in group A, 6.3% in group B, and 10.4% in group C. Perioperative MI occurred in 5.6% of group A, 6.5% of group B, and 13.1% of group C [113].

Ivert et al., 1989, reported a 5% early mortality and a 19% peri- operative MI rate with 85% and 68%% survival rates at 5- and 10- year follow-up respectively in 75 patients who underwent adjunctive CE. At angiography at a median time of 25 months postoperatively, all three ITA grafts and 56% (19/34) of SVG were patent [114].

In a second publication by Brenowitz and colleagues (1988), the patency rate of endarterectomised vessels at more than 12 months was found to be 89% with no significant differences between endarterectomised grafts and conventional grafts in 144 patients with triple CE [115].

In 1989, Minale and colleagues reported the outcomes of 635 patients who underwent CE and found that the early mortality was higher in patients with multiple CEs (7.8% versus (vs) 2.3%). Of those, 59 patients underwent angiography (18 months) which revealed a 55% re-occlusion rate [116].

The latter studies 1990-2004

In 1990, Sommerhaug et al. published the early results of 130 patients who underwent CE (open technique and mainly of the LAD) adjunct to CABG with the operative mortality at 2.3% and peri- operative MI at 1.5%. Angiography in 24 patients within 20 days post-operatively showed that 32 of 33 CE conduits (97%) were patent[117].

In 1992, Beretta and colleagues studied the outcomes of 96 patients who underwent open CE as an adjunct to CABG either using SVG (group 1; 50 patients) or IMA (group 2; 41 patients). The operative mortality and the peri-operative MI rates were higher in the SVG group. Furthermore, the patency rate, survival rate and the improvement of symptoms were all superior in the IMA group [118].

Djalilian et al. (1995) studied 64 CE patients for a mean follow- up of 46 months and in 17 of them, the patency was 80% compared with 78% for conventional grafts ($p <$

0.05). The actuarial survival rates were 89% vs 71% at 1 year and 5 years, respectively [119].

A separate study of 106 patients who underwent open CE of the LAD by Christenson et al., in 1995, found a reduced mortality, survival and cardiac event-free rates when IMA was used [120].

In 1996, Tasdemir and colleagues conducted a retrospective comparative study of patients who either had LAD reconstruction with (group 1) or without (group 2) open CE or CABG alone (group3). Group 1 had the highest in-hospital mortality and perioperative MI. However, group 1 had an improved patency rate compared with group 2, although it was inferior to group 3 [121].

Furthermore, in 1998, Gill et al. retrospectively studied 74 patients who underwent CABG using the left ITA and CE of the LAD. There were 3 (4.0%) early and 4 (5.4%) late deaths at a mean follow up of 36 ± 16 months. Angiographic follow-up obtained in 23 patients demonstrated 74% anastomotic patency, with good distal run-off in 13 [122].

The recent studies: 2005 - 2015

In 2005, Nishi et al. conducted a study of 127 patients to compare the open and closed technique. The perioperative MI rate was 3%, whereas the 30-day mortality was 2.9% vs 6.8% (open vs closed technique) but not significantly different between the two groups. The angiographic patency rate (78 patients at 21 ± 16 months) was superior in the open technique group (89.1% vs 81.0%) [123].

In the retrospective study of Fukui et al. (2005), 250 patients were treated with CABG with or without (183) CE. Angiography at 15.4 ± 7.2 months in 54 CE patients showed that the patency of both LITA and LAD, including side branches, was 94.4% [124].

Sachweh and colleagues conducted an angiographic study of 50 patients who had CABG with CE of the LAD. Significant ($p < 0.001$) clinical improvement (CCS class I/II) was found in 39 patients (78%). At 7.6 ± 2.5-year follow-up, 30 (60%) of the patients had a patent LAD. After 2, 5 and 10 years, graft patency was found to be

100%, 96% and 56% respectively and lower in patients suffering from diabetes (p ¼ 0.001) [125].

In 2011, Fukui and colleagues retrospectively reviewed the results of 213 patients who underwent reconstruction of the LAD using an ITA graft, 98 of whom also had adjunctive CE (operative mortality was 1.4%, perioperative MI was 5.2% and re-exploration for bleeding was significantly increased (p ¼ 0.036) in the extensive reconstruction group). The early and 1-year patency rates of the ITA to LAD grafting were 95.7% and 93.4%, respectively. Early angiographic study was performed in 188 patients. Eight patients had occluded vessels, 7 of whom had undergone CE (p ¼ 0.028) [126].

In 2014, Qiu and colleagues compared the outcomes of on- (120 patients) and off-pump (92 patients) open CE. Angiographic studies showed early patency rates of 94.5% vs 94.9%, and midterm patency rates of 91.7% vs 90.3% for the on- and off-pump groups respectively. No significant difference between the two groups was found in any of the aforementioned outcomes [127].

Recently in 2015, Kato and colleagues sought to determine the difference in outcome between patients with high and low CAD complexity following CABG and LAD reconstruction with or without CE. 102 patients with triple vessel disease and/or left main disease were divided into a high (50 patients, 32 had CE) or low (52 patients, 18 had CE) SYNTAX score group. On early angiography studies, even though 98% of patients had a patent LIMA, the distal LAD in 6 patients with LAD reconstruction and CE was occluded. At long-term follow up (9.4 ± 0.6 years), only one patient needed PCI to the LAD [128].

Recently, the use of percutaneous coronary intervention (PCI) for treatment of coronary artery disease has progressively increased. A large number of simple stenoses in one or two coronary vessels can be treated by PCI. Therefore, the number of high-risk and severely diseased patients referred for coronary artery bypass grafting (CABG) has been relatively increasing. Coronary endarterectomy has been used to treat severely or diffusely diseased coronary arteries since the 1950s [129]. However, early experiences of this method were not associated with satisfactory clinical results [130]. More recently, the benefits of endarterectomy for the left anterior

descending artery (LAD) have gradually become recognized because surgical techniques and technologies have evolved [131]. The greatest advantage of endarterectomy is that the myocardium supplied by the side branches (diagonal branches and septal perforators) of a diffusely diseased LAD can be relieved of ischemia. This advantage cannot be obtained using a conventional graft to the distal LAD alone because this is beyond the diffusely diseased segments.

The diffusely diseased coronary artery is a challenge for cardiac surgeons. Although coronary endarterectomy is an option for surgical reconstruction of a diffusely diseased vessel, it has not been widely used. Kato et al assessed the early clinical and angiographic outcomes of patients undergoing coronary endarterectomy of the left anterior descending artery (LAD) with a patch plasty method using the left internal thoracic artery (LITA) (figure 1). Furthermore, Kato et al assessed the coronary artery velocity flow reserve (CFVR) of the endarterectomized LAD.

They retrospectively reviewed the records of 148 patients undergoing LAD endarterectomy using the in-situ LITA. Direct endarterectomy was performed with a long segmental incision of the LAD that was reconstructed with the longitudinally incised LITA. The mean age at surgery was 65.1±8.6 years. Previous myocardial infarction was observed in 58.1% of the patients. The mean Canadian Cardiovascular Society score was 2.4 ± 0.9. Postoperative angiography was performed in 134 patients (91.2%) during the same hospitalization (mean, 11.2±9.0 postoperative days). CFVR in the LAD was measured early after the operation by transthoracic echocardiography.

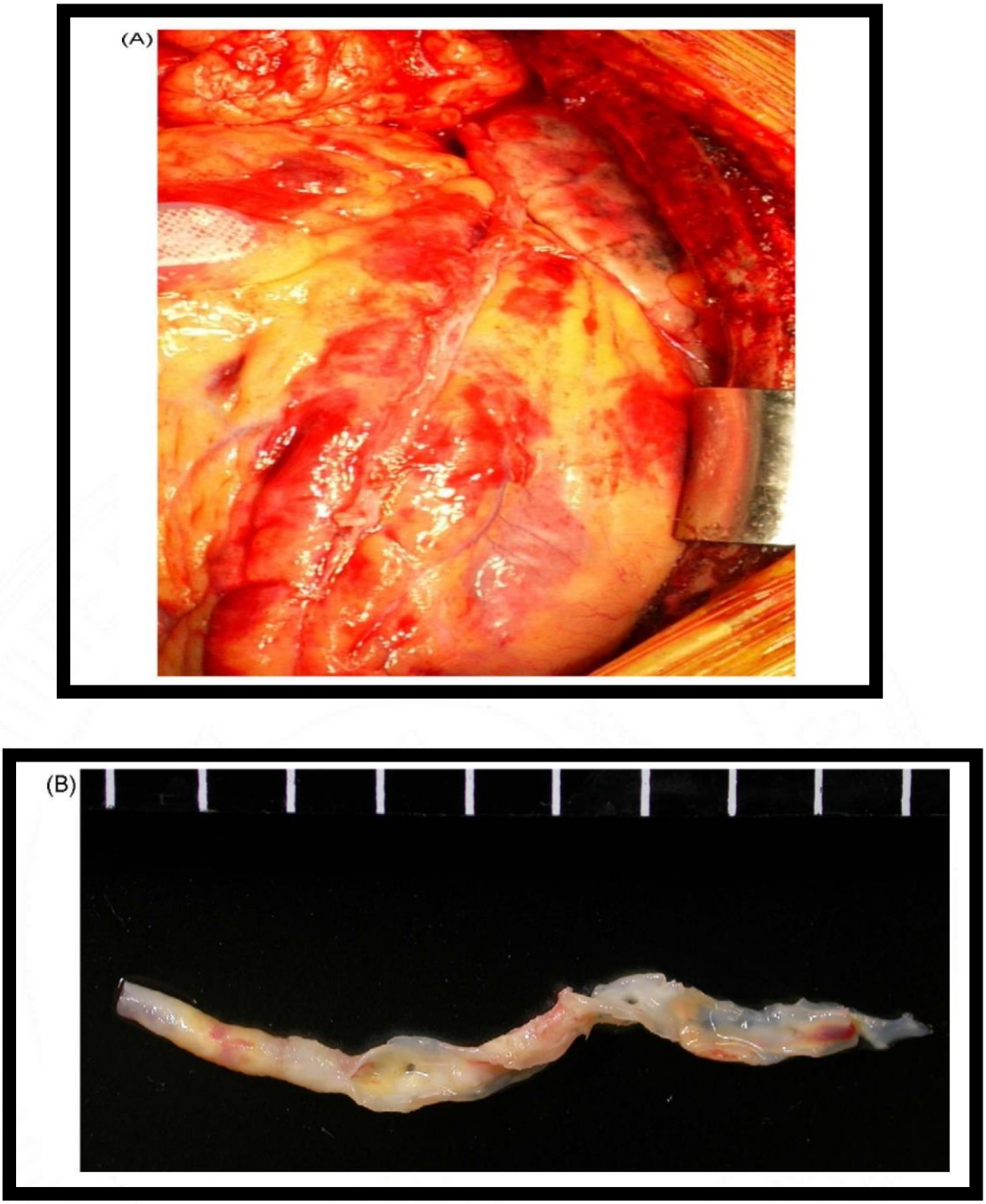
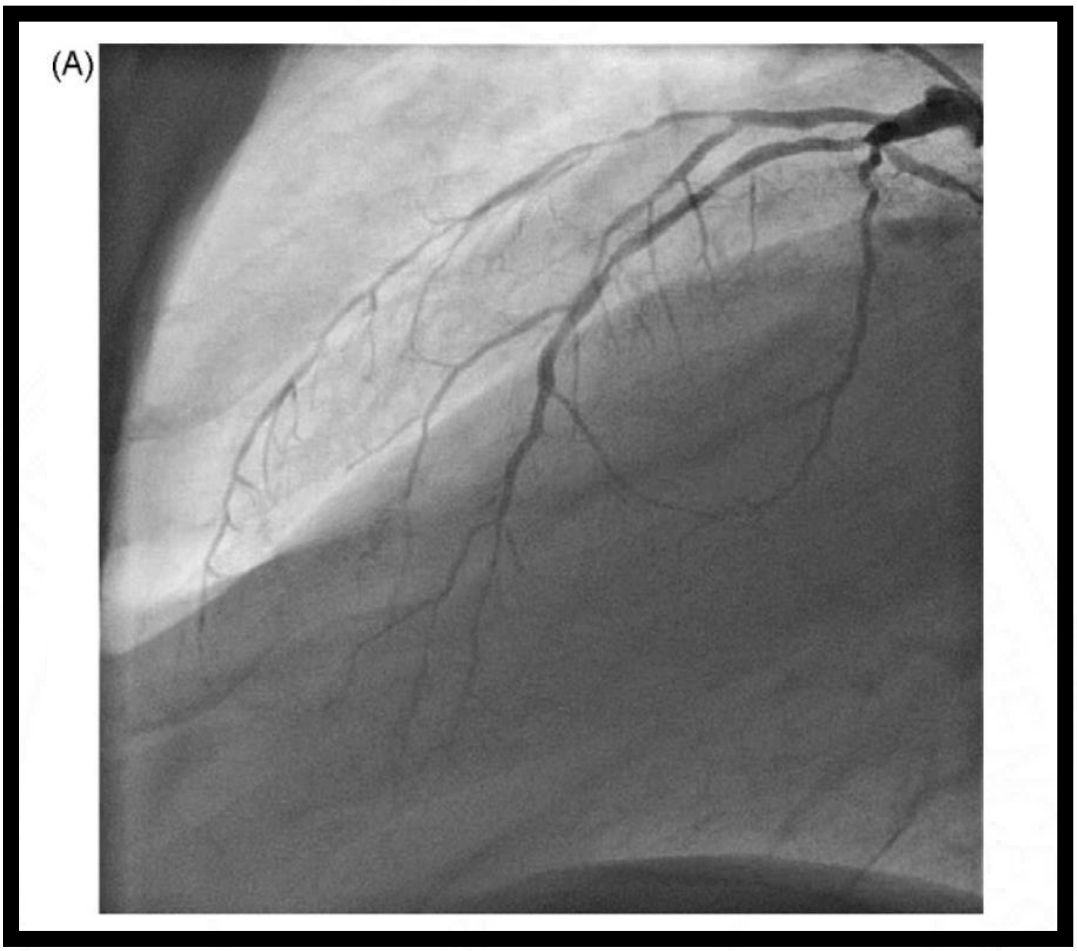


Fig :1 Intraoperative photographs. (A) The left anterior descending artery was reconstructed with a long segmental patch anastomosis using the left internal thoracic artery. (B) A specimen of the endarterectomized core.

Results: The mean number of distal anastomoses per patient was 4.2 ± 1.3. The mean length of reconstructed LAD with endarterectomy was 5.8 ± 1.5 cm. The operative mortality was 2.7%. Low cardiac output occurred in 6.1% of the patients.

Perioperative myocardial infarction was observed in 12.2% of the patients, but severe ventricular arrhythmia was not encountered. The patency rate of the LITA to LAD was 94.0% by early angiographic examination. The mean CFVR in the endarterectomized LAD was 2.41 ± 0.66.



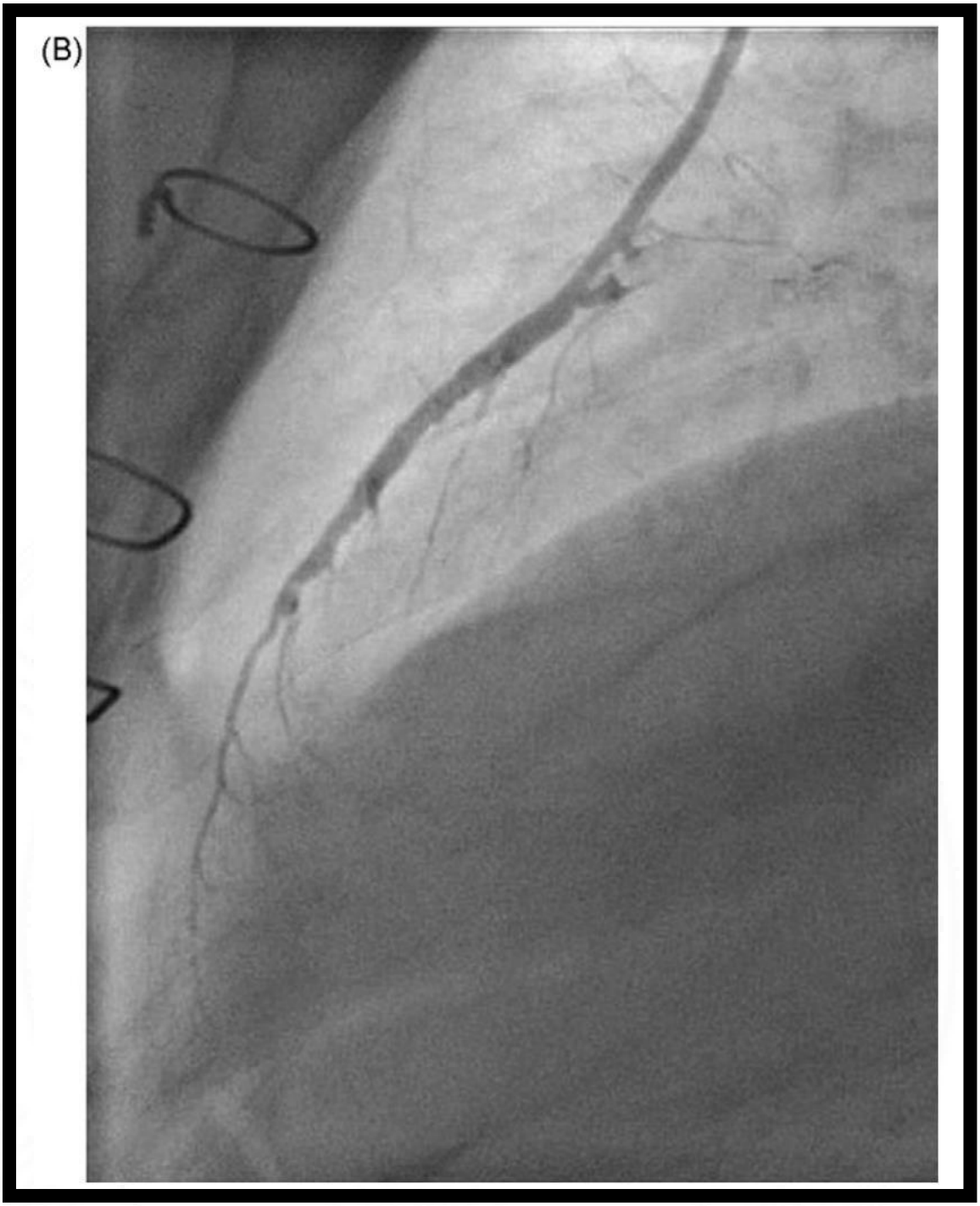


Fig. 2 Preoperative and postoperative angiography of the left anterior descending artery endarterectomy. (A) Preoperative angiography shows a diffusely diseased left anterior descending artery. (B) Postoperative angiography shows an endarterectomized left anterior descending artery reconstructed with the left internal thoracic artery.

However coronary endarterectomy appears as a valuable surgical option in the face of diffuse CAD when complete revascularization cannot otherwise be obtained[132], although only highly experienced surgeons should perform this procedure, as it is not technically simple [133]. Moreover, acceptable mortality, morbidity, and angiographic patency rates accompany coronary endarterectomy, regardless of the coronary vessel endarterectomized [134] However, patients' prognosis is significantly worsened by a second endarterectomy [135.] Overall, coronary endarterectomy should not replace CABG, but it is an adjunctive to CABG treatment and it is not appropriate for each patient undergoing bypass surgery [136]. Coronary endarterectomy should be applied only when the artery to be endarterectomized supplies blood to a coronary bed of at least moderate size so that incomplete revascularization would result in residual angina.

METHODS AND METHODOLOGY

Study Type - A Retrospective observational study

Study Population – All patients who underwent coronary artery bypass grafting with coronary endarterectomy at SCTIMST during period of 01/01/2000 to 31/12/2010

Data collection procedure – All patients who underwent coronary artery bypass grafting with coronary endarterectomy at SCTIMST during period of 01/01/2000 to 31/12/2010

and who satisfied the inclusion and exclusion criteria were included in the study . Retrospective analysis was performed by principal investigator after going through medical records. All the patients underwent follow up after the procedure and routinely as per departmental protocol. Follow up involved Transthoracic ECHO, ECG, Chest X-ray and INR monitoring. Patients who were lost to follow up were contacted through Telephonic interview. Patients were asked about symptoms in the follow up period. Data so collected from the medical records and telephonic interview was analyzed. Procedure DID NOT involve banking of biological samples, HIV testing, Genetic testing

Eligibility Criteria

Inclusion Criteria–

Patients with coronary artery disease who has undergone coronary artery bypass grafting with coronary Endarterectomy at SCTIMST during period of 01/01/2000 to 31/12/2010

Exclusion Criteria–

- Patients who underwent any other concomitant procedures such as carotid endarterectomy, Valve repair or replacement along with Coronary Artery Bypass Grafting (CABG) were excluded.
- Redo – CABG were excluded.

- Gender, class, caste, ethnicity, race, will NOT be used as Inclusion and/or Exclusion criteria.

Sample Size:

62 patients who underwent coronary endarterectomy along with CABG during the period 2000-2010 at SCTIMST and satisfied the inclusion and exclusion criteria were included in study.

Operative techniques

All 62 patients who underwent coronary artery bypass graft with coronary endarterectomy were studied. Standard intra-operative monitoring strategies were utilized and a cardiopulmonary bypass (CPB) circuit was used for most of the cases. All procedures were performed through a standard median sternotomy. Heparin was used to maintain an activated clotting time more than 400 seconds during harvesting of conduits (internal mammary artery, the saphenous vein and sometimes radial artery). Almost all the operations were performed using ONPUMP CABG procedure except in a few cases where the assistance of CPB was not required where mechanical stabilizers such as suction type to immobilize the target coronary artery during grafting were used Cardiopulmonary bypass (CPB) was established by routine aorto-right atrial cannulation. A conclusive decision to endarterectomize a vessel was made per operatively and CE was considered when localized lesion blocked a sufficient distal stream (i.e.complete occlusion), distal diffuse lesion or multi-segmental lesion, as well as when a calcified or extremely thick plaque burst, making anastomosis troublesome or hindering the stream. Coronary endarterectomies were performed manually by slow sustain and continuous traction of atheromatous plaque with the aid of delicate Ring Forceps, right angled artery forceps utilizing the closed methods trailed by reproduction with anastomosis with pre-planned graft. The arteriotomy incision was approximately 8–10 mm long, but could be stretched out for another 5 mm in some cases, if complete removal of the plaque was not feasible. Exceptionally sensitive ring forceps/coronary artery endarterectomy dissector (Figure 3) were utilized to build up a plane between the media and the atherosclerotic plaque.

With slow sustain and continuous traction, the plaque removal was attempted, with the assistance of another ring forceps (counter traction), facilitating the expulsion of the biggest portion of plaque. Close consideration was paid to the entire expulsion of the distal segment; proximal traction of the plaque was avoided usually in the interventricular artery because of the danger of proximal dissection and the impediment of a wide septal branch, oblique branches or even of the circumflex artery. Subsequently, to finish distal anastomosis incision in the conduits was extended to coordinate the arteriotomy, with the exception of few situations where venous patch was utilized. To ensure complete expulsion, the atheromatous plaque was carefully inspected for a smooth distal tapper end. In addition, back flow of blood from the distal vessel following extraction of the atheroma is a consoling indication of adequate removal of atheromatous plaque and that is a special feature in OPCABG endarterectomy. Every patient was monitored in intensive care unit (ICU) for close observation and management. In early post-operative period, patient was treated with heparin bridging to warfarin from the first post-operative day to the next 3–6 months. Aspirin was given orally at the dose of 150 mg o.d. to prevent acute thrombosis within the graft as well as the endarterectomized artery. Warfarin was typically started at 3 mg daily for first two post operative days followed by 2/1 mg for next 3 to 6 months with the dose adjusted according to INR level (our local targeted INR was 1.5–2.0)

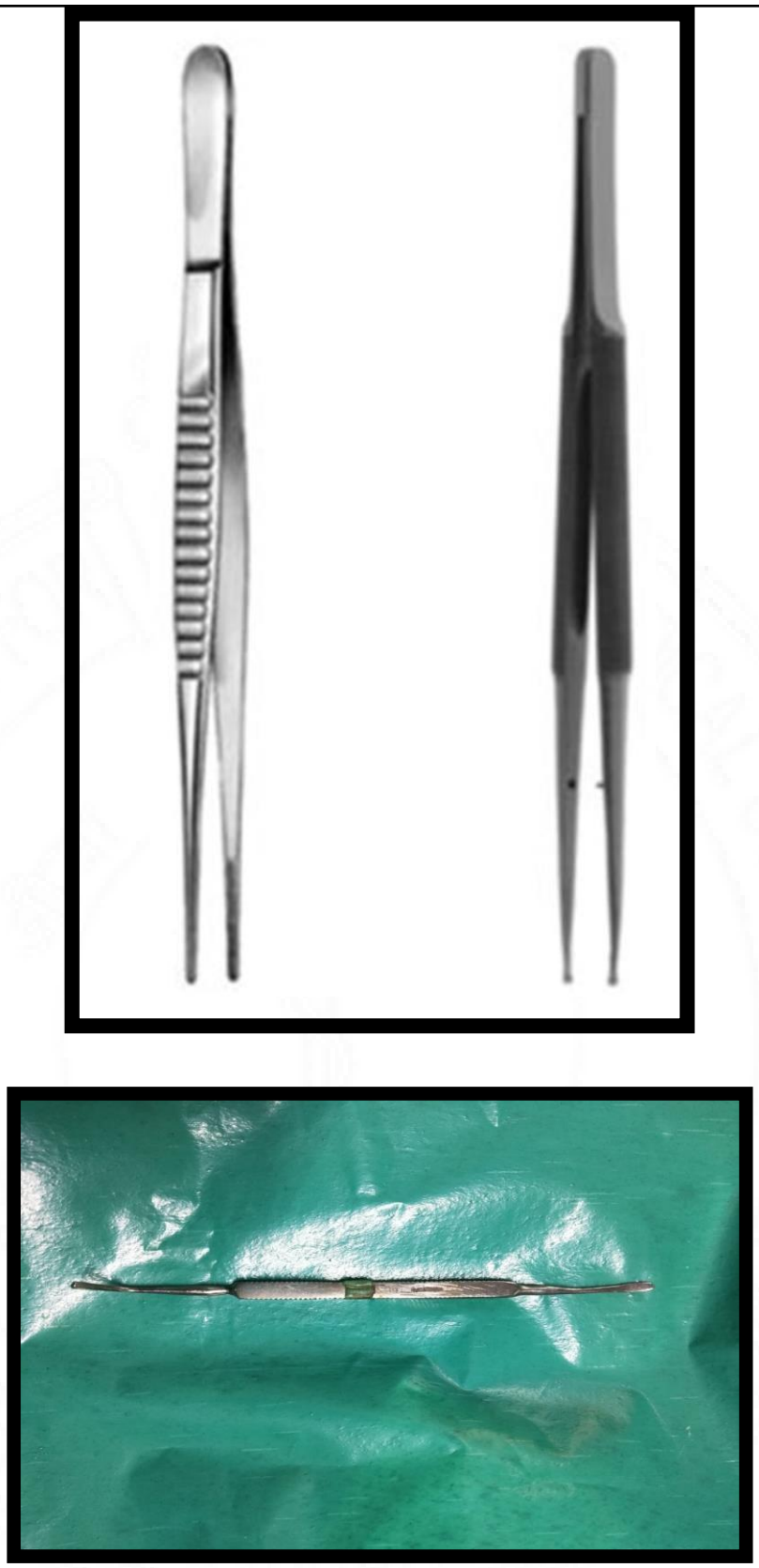


Figure 3: Instruments used for the removal of the atheromatous plaque during coronary artery bypass grafting

RESULT

Patient Selection

Total of 62 patients underwent coronary artery bypass grafting with coronary endarterectomy and were included in the study.61 patients were Elective and 1 patient was taken up as Emergency procedure.

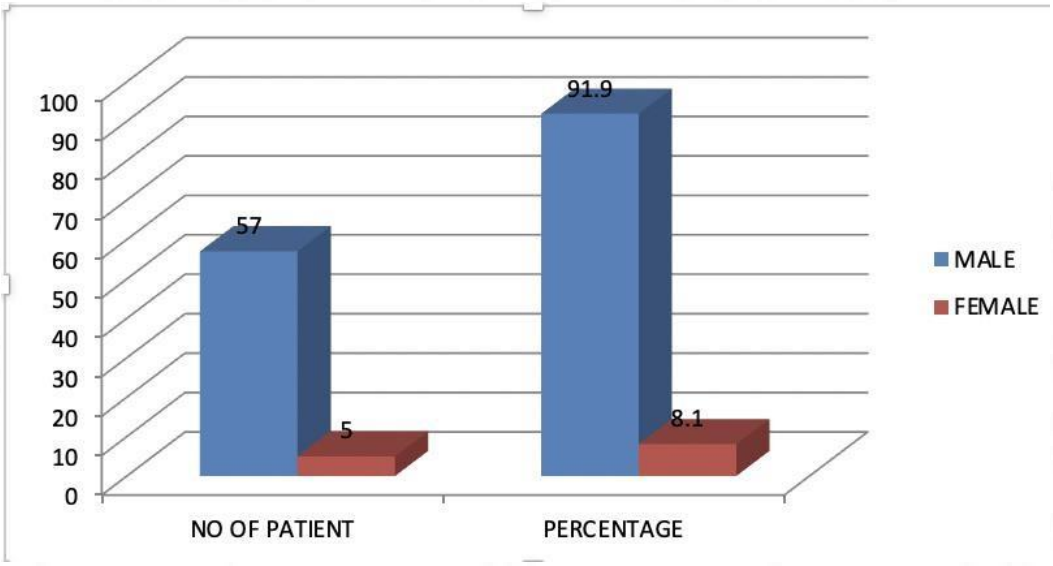


Figure 4: Gender distribution

Out of 62 patients,57(91.9%) patients were males and 5 patients (8.1%) were females.

Gender	Frequency	Percent
Male	57	91.9
Female	05	8.1
Total	62	100

Table 4: Gender distribution

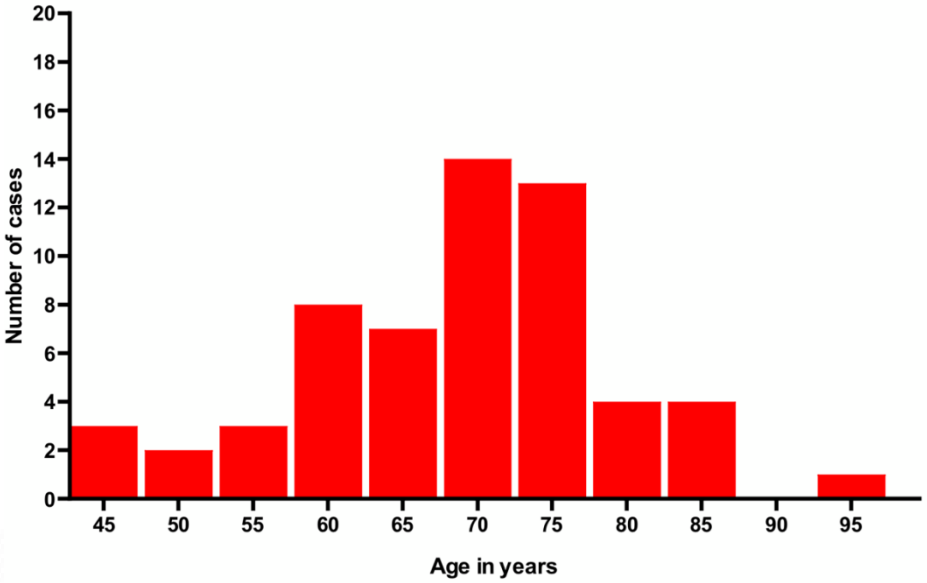


Figure 5: Age Distribution

Mean age was 68.5 +/-10 years

COMORBIDITIES AND RISK FACTORS	NO OF PATIENTS	PERCENTAGE
DIABETES	40	64.5
HTN	23	37.1
SMOKING	21	33.9
DYSLIPIDAEMIC	15	24.2

Table 5: Comorbidities and Risk factors

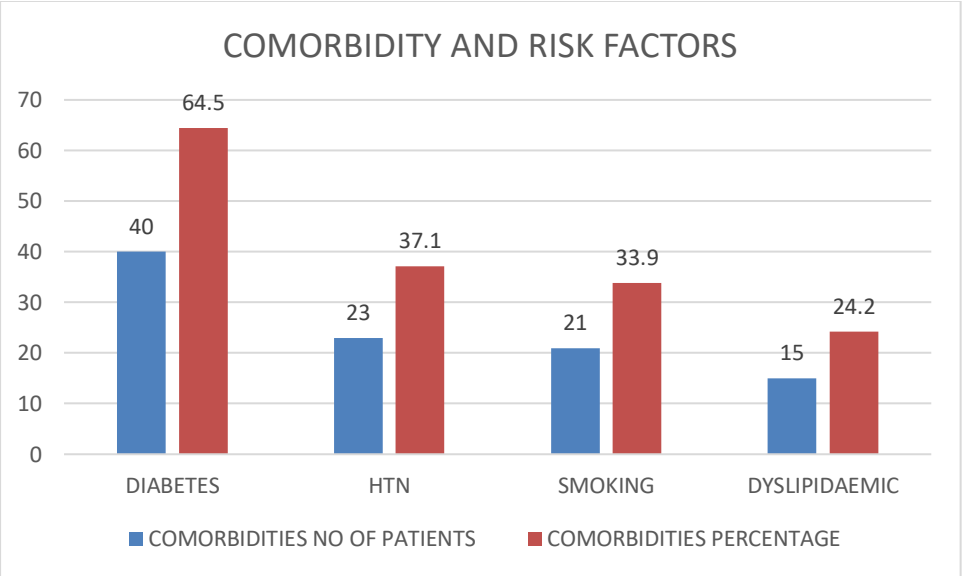


Figure 6: Comorbidities and Risk factors

Most common risk factor associated in our study with coronary artery disease was diabetes, present in 40 patients (64.5%), Hypertension in 32 patients (37.1%),21 patients have history of smoking (33.9%), and 15 patients were dyslipidemia (24.2%).

Majority of the patients 64.5 % who underwent coronary endarterectomy were diabetic.

DISEASED VESSEL	NO OF PATIENT	PERCENTAGE
DOUBLE VESSEL DISEASE	1	1.6
TRIPLE VESSEL DISEASE	60	96.8

Table 6: Coronary vessel involvement

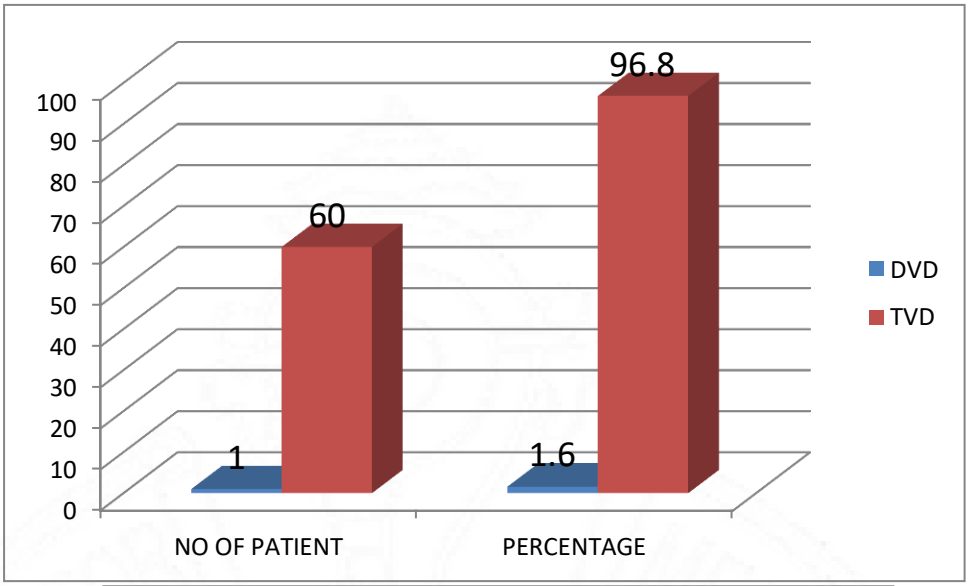


Figure 7: Coronary artery involvement

Out of 62 patients, 61 no of patients (96.8%) had triple vessel disease and only 1 patient (1.6%) had double vessel disease.

FUNCTIONAL CLASS	PRE-OP	POST OP AT DISCHARGE
I	O	13(21%
II	8(12.9%)	44(71%)
III	54(87.1%	4(6.5%)

Table 7: Functional Class

There was an improvement in the Functional Status post operatively and it was statistically significant with P value <0.001)

LV FUNCTION	PRE-OP LV FUNCTION	IMMEDIATE POST OP LV FUNCTION
GOOD LV FUNCTION	54(87.1%)	54(87.1%)
FAIR LV FUNCTION	1(1.6%)	1(1.6%)
MILD LV DYSFUNCTION	1(1.6%)	2(3.2%)
MODERATE LV DYSFUNCTION	2(3.2%)	2(3.2%)
SEVERE LV DYSFUNCTION	4(6.5%)	3(4.8%)

Table 8: LV Function

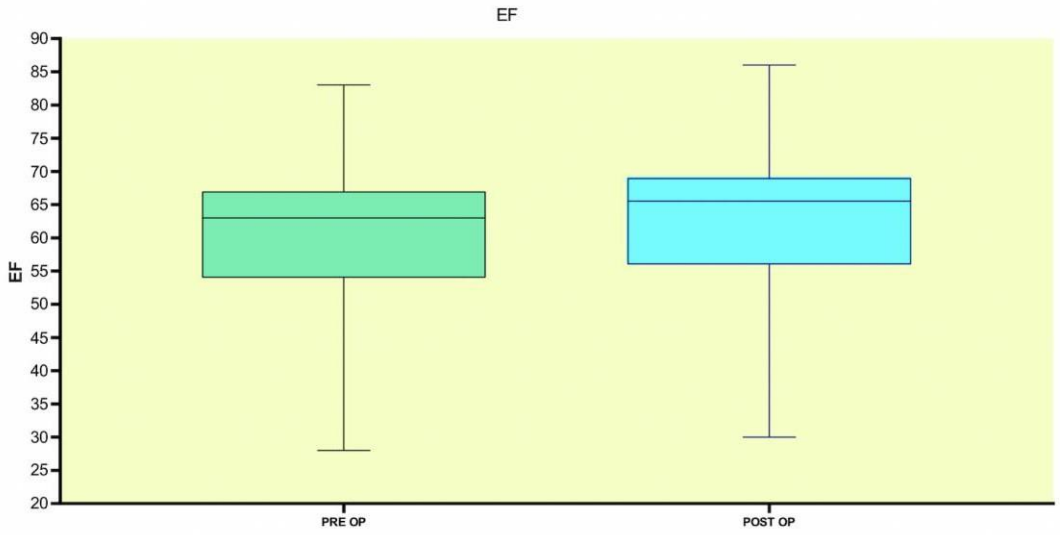


Figure 8: comparison of Preoperative and Post Operative Ejection fraction

Mean Pre operative EF was (61+/-10.6) and Mean postoperative EF was 63.7+/-10.7.There was improvement in the postoperative EF compared to pre operative EF and the difference was statistically significant P value - <0.001

ON PUMP/OF PUMP	NO OF PATIENTS	percentage
ON PUMP	61	98.4
OPCABG	1	1.6

Table 9: ON pump v/s off pump

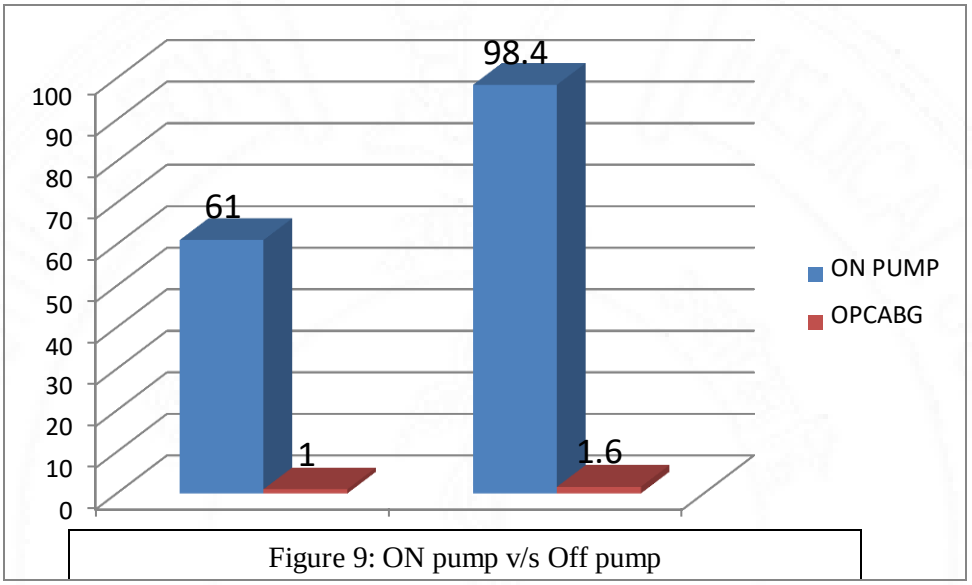


Figure 9: ON pump v/s Off pump

Out of 62 patients, 61 patients underwent surgery using Cardiopulmonary bypass (98.4%) and one patient underwent surgery OPCABG (1.6%)

NO OF GRAFTS	NO OF PATIENTS	PERCENTAGE
I	1	1.6
III	10	16.1
IV	32	51.6
V	17	27.4
VI	2	3.2

Table 10: Number of Grafts

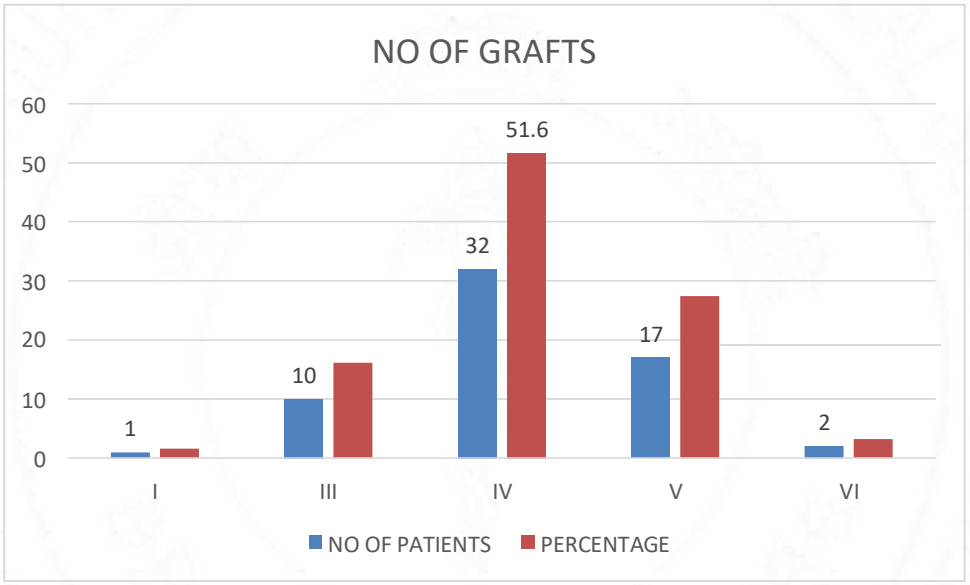


Figure 10: Number of Grafts

Out of 62, More than half of patients (32 patients) had four number of grafts (51.6%), followed by five grafts in 17 patients (27.4)% and three grafts in 10 patients (16.1 %) and six graft in 2 patients (3.2 %)

.

NO OF VENOUS GRAFT	TOTAL PATIENTS	PERCENTAGE
I	1	1.6%
II	9	14.5%
III	33	53%
IV	17	27.4%
V	2	3.2%

Table 11: Number of venous Grafts

Out of total patients 62,33 patients (53%) patients had 3 venous grafts followed by 17 (27.4%) patients had 4 number of venous graft and 9 (16.1%) patients had 2 venous graft and one patients (1.6%) with one venous graft in our study.

ARTERIAL CONDUITS

60 patients received left internal mammary artery anastomosis to LAD,2 patients have only venous graft as conduits

VESSEL ENDARTERECTOMISED	NO OF PATIENTS	PERCENTAGE
LAD	15	24.2
DIAGONAL ONE	2	3.2.
OM1	2	3.2
OM2	4	6.5
OM3	1	1.6
RCA	31	50.0
PDA	7	11.3

Table 12: Vessel Endarterectomised

VARIABLES	MEAN
Cross clamp time	73.3 ± 31.8 min
CPB time	119.2 ± 40.9min
Ventilation hours	15 ± 2.9 hours
Hospital stay in days	10.5 ± 4.8 days
ICU stay in days	5.3 ± 2.9 days

Table 13: Intraoperative and post operative course.

The most common vessel to undergo endarterectomy was RCA ,31 patients (50%). Endarterectomy of LAD was done in 15 (24.2%) patients PDA artery was done in 7 patients (11.3%), followed by OM2 – four patients (6.5%), OM -1 in 2 patients (3.2%), OM-3-1 patients (1.6%).

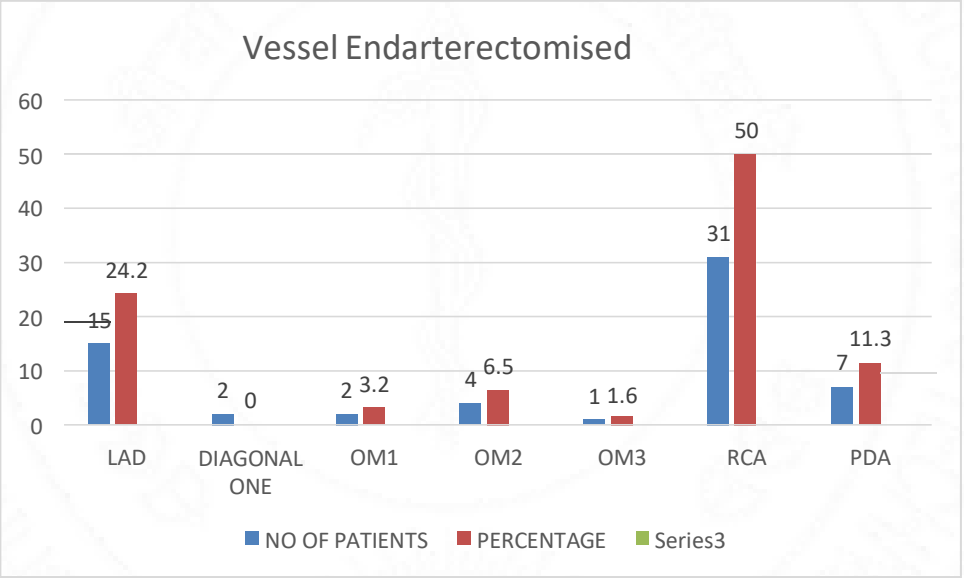


Figure 11: Vessel Endarterectomised

The mean age at surgery was 68.5 ±8 years. The mean cross clamp time was 73.3 ±31.8 minutes, and cardiopulmonary bypass time was 119 ±40.9 minutes. Mean Ventilation hour were 15 ±2.9 hours. Mean Hospital stay was 10.5 ±4.8 days and

mean ICU stay was 5.3 ±2.9 days in our study.

MORTALITY

Total mortality – 5 patients (8.06%)

In hospital mortality was 1(1.6%) due to multi-organ dysfunction following low cardiacoutput.

Out of 5, four mortalities happened outside the hospital for which cause could not be ascertained even after telephonic conversation with the bystanders.

MORTALITY	TOTAL NO OF PATIENT	PERCENTAGE
5	62	8.06%

Table 14: Mortality.

Duration of Survival in years		
Mean	se	95% CI of mean
19.7	0.69	18.31 to 21.03

Table 15: Duration of Survival in years

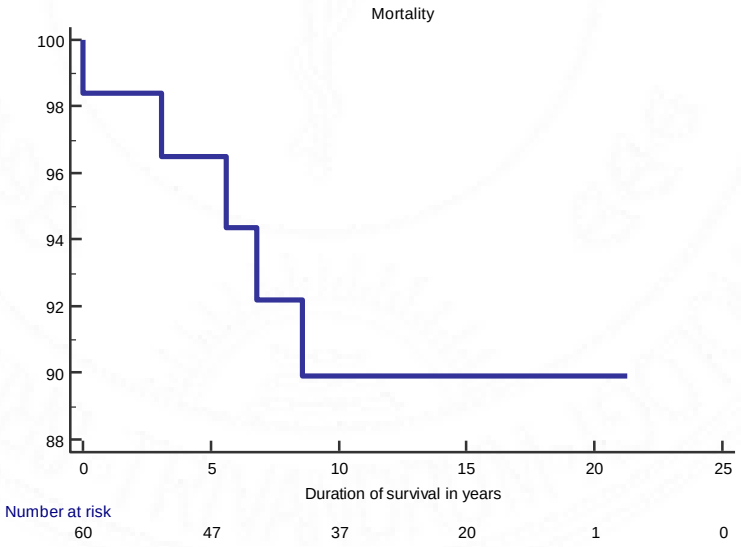


Figure 12: Mortality

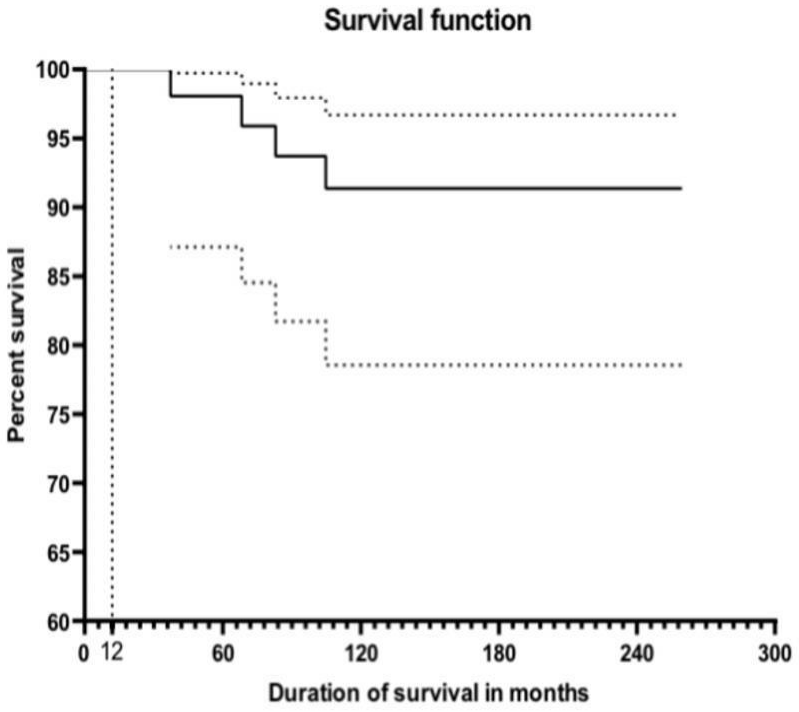


Figure 13: Kaplan-Meier Survival Curve.

Kaplan-Meier Survival curve showing the estimated survival probabilities.

Survival Time	Proportion	95% CI
1 year	98.4%	95.3-100%
5 year	96.5%	91.7-100%
10 year	89.9%	81.4-98.4%

Figure 14: Duration of Survival in years

The estimated 1-year survival is 98.45%, 5-year survival was 96.5% and 10-year survival was 89.9 %

MAJOR ADVERSE CARDIAC AND CEREBROVASCULAR EVENTS (MACCE)

Two patients had stroke; another two patients had acute myocardial infarction after 2 years ofsurgery for which PCI was done. There were no re-operations.

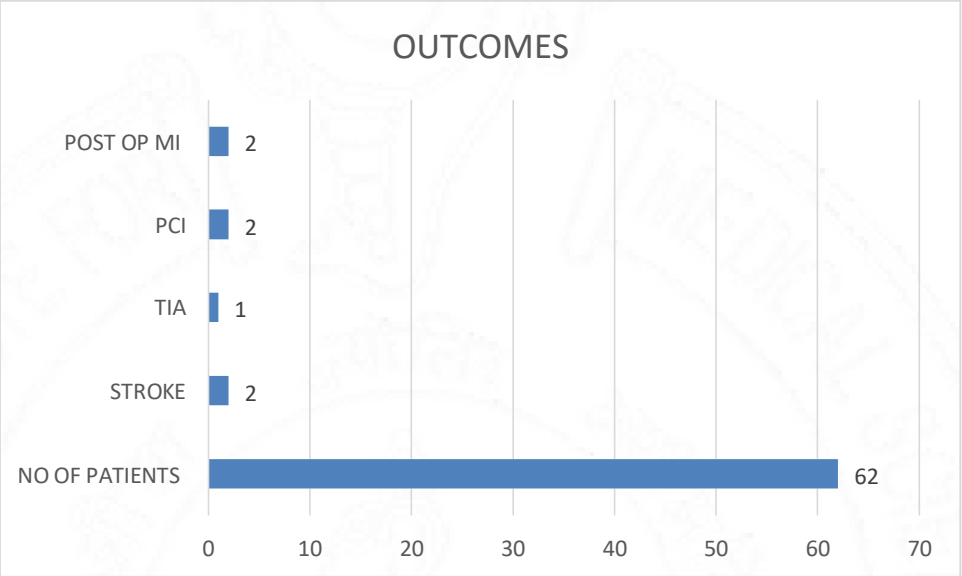


Figure 14: Major adverse cardiac and cerebrovascular events

NO OF PATIENTS	STROKE	TIA	PCI	POST OP MI
62	2	1	2	2

		Death		Survive		Total		P VALUE
		NUMBER	PECENTAGE	NUMBER	PERCENTAGE	NUMBER	PERCENTAGE	
AGE	≤70	1	3.2	30	96.8	31	100	
	>70	4	12.9	31	85.7	31	100	0.18
GENDER								
	Female	0	0	5	100	5	100	
	Male	5	8.8	52	91.2	57	100	1
ARTERIAL GRAFT								
	NO	0	0	2	100	2	100	
	YES	5	8.3	55	91.7	60	100	1
STROKE								
	NO	5	8.3	55	91.7	60	100	
	YES	0	0	2	100	2	100	1
TIA								
	NO	5	8.2	56	91.8	61	100	
	YES	0	0	1	100	1	100	1
DEEP STERNAL WOUNDINFECTION								
	NO	5	8.2	56	91.8	61	100	
	YES	0	0	1	100	1	100	1
OFF PUMP/ON PUMP								
	O	0	0	1	100	1	100	
	ON	5	8.2	56	91.8	61	100	1
VESSEL ENDARTERECTOMISED								

	DIAGONAL ONE	1	50	1	50	2	100	
	LAD	1	6.7	14	93.3	15	100	
	OM1	0	0	2	100	2	100	
	OM2	0	0	4	100	4	100	
	OM3	0	0	1	100	1	100	
	PDA	0	0	7	100	7	100	
	RCA	3	9.7	28	90.3	31	100	0.511
IABP								
	NO	4	6.6	57	93.4	61	100	
	YES	1	100	0	0	1	100	0.081
PRE OP FUNCTIONALCLASS								
	2	1	12.5	7	87.5	8	100	
	3	4	7.4	50	92.6	54	100	0.511
POST OP FUNCTIONAL CLASS								
	1	1	7.7	12	92.3	13	100	
	2	3	6.8	41	93.2	44	100	
	3	0	0	4	100	4	100	1
PRE OP LV FUNCTION								
	Good	3	5.6	51	94.4	54	100	
	Fair	0	0	1	100	1	100	
	Mild	1	100	0	0	1	100	
	Moderate	0	0	2	100	2	100	
	Severe	1	25	3	75	4	100	0.067
POST OP LV FUNCTION								
	Good	3	5.6	51	94.4	54	100	
	Fair	0	0	1	100	1	100	

	Mild	1	50	1	50	2	100	
	Moderate	0	0	2	100	2	100	
	Severe	1	33.3	2	66.7	3	100	0.12
DIABETES								
	NO	0	0	22	100	22	100	
	YES	5	12.5	35	87.5	40	100	0.151
HTN								
	NO	2	5.1	37	94.9	39	100	
	YES	3	13	20	87	23	100	0.35
SMOKER								
	NO	2	4.9	39	95.1	41	100	
	YES	3	14.3	18	85.7	21	100	0.325
DYSLIPIDAEMIC								
	NO	3	6.4	44	93.6	47	100	
	YES	2	13.3	13	86.7	15	100	0.587
REXPLORATION								
	NO	5	8.2	56	91.8	61	100	
	YES	0	0	1	100	1	100	1

Table 15: variables studied in relation with mortality

Out of above variable studied none of them have any significant relation with mortality .

DISCUSSION

Coronary endarterectomy is a surgical procedure performed alongside CABG for the treatment of diffuse CAD. It involves an arteriotomy of the coronary artery and the excision of the atheromatous plaque occluding the vessel in order to revascularise the ischaemic myocardium and improve the success rate and safety of CABG. CE is performed in a highly selected group of patients with severe atherosclerotic disease.

In a study by Djalilian et al, where LIMA was used to anastomose with LAD in 100% of cases. Previously, the internal mammary artery (IMA) has been utilized cautiously as a conduit to an endarterectomized vessel, but many authors have shown satisfactory early and late clinical results with luminal patency of IMA to an endarterectomized vessel compared to great saphenous vein conduit.[147] Acute MI due to acute graft occlusion is a noteworthy complication following CE with an incidence rate of 1.5–19%.[148] The occurrence of postoperative MI in Djalilian et al study patients were only 3.5% compared to a study by Naseri et al[149] who observed higher postoperative MI rate of 6.8% after CABG with CE. In our study 15 Patients underwent LAD endarterectomy and all the patients received LIMA to LAD anastomosis and Acute MI as a late postoperative complication was seen in only 1 (1.6%) patient among those 15 patients. However, in another study, Vohra et al[150] observed that postoperative MI rate following OPCABG with CE was 4.3%. In our study of, the early mortality rate in ICU was of 1.6%, which is consistent with findings form previous studies by Carega et al.[150] The frequency of early mortality following CE with CABG has been found to be between 2% and 15%.

The incidence of three-vessel disease and diffuse coronary artery disease is increasing worldwide, necessitating the use of coronary artery endarterectomy as a procedure. The rate of CE with CABG surgeries is reported somewhere between 3.7%-42% at different institutions, which shows that a significant number of the population has required it.

In a study by Soylu et al[151], the risk factors identified with mortality associated with CE were female gender, diabetes mellitus, left main disease, acute MI, previous

myocardial revascularisation and ejection fraction <35%. We didn't find any variables relating to mortality. Recent investigations have shown that endarterectomy with /without use of cardiopulmonary bypass (off-pump CABG) can be performed safely. In our study we have performed coronary endarterectomy safely and effectively in 62 patients with 61 patients (98.4%) on pump and 1 patient (1.6%) OPCABG.

In a study Xin Chen et al,who studied the survival outcomes of coronary endarterectomy in coronary artery bypass grafting where Kaplan-Meier survival estimates outcome survival at 1, 5 and 10 years were 96%, 89% and 73% respectively. In our study Kaplan-Meier survival curve at 1,5, and 10 years were 98.45%,96.5%, and 89.9 % respectively. Although 1 year outcome is comparable but 5 year and 10-year outcomes are significantly better.

The ultimate aim of Coronary endarterectomy is to ensure a patent coronary artery. The general impression from Xin Chen et al review is that CE is accompanied by acceptable patency rates, that ranged from 56% to 100% at a post-operative follow-up ranging from 2 months [154] to 10 years despite the significant heterogeneity between the study's methodology and design. A patent endarterectomised artery leads to improvement of symptoms and reduction in Cerebro vascular events. 90% of patients at 1 year and 84% at 5 years respectively reported freedom from angina, MI, congestive heart failure and admission to hospital in a study by Byrne et al. In our Study the freedom from Angina and myocardial infarction and stroke was 96.8% at 10 years which is better than the previous mentioned studies. In our study one patient was kept on IABP in post operative period and one patient had deep sternal wound infection.

The risk of cardiac complications was increased significantly by coronary endarterectomy. The incidence of myocardial infarction after endarterectomy(5.4%) in a study done by James et al[154], Nevertheless, the incidence of myocardial infarction has declined substantially from the 10% to 30% rate reported previously for ischemic arrest. Advances in methods of myocardial preservation have extended the

limits of safe arrest and have allowed the necessary time and optimal conditions for endarterectomy and multiple vessel grafting. Most studies on endarterectomy have reported an increased risk of perioperative myocardial infarction, but in our study, we didn't have any incidence of perioperative myocardial infarction.

In a study by Marzab et al out of 271 patients included in study 70 patients (25.8%) were double vessel disease and 201 patients (74.2%) were triple vessel disease. In our study 60 patients (96.8% were triple vessel disease and 1 patient (1.6%) had double vessel disease.

In a study performed by Andre et al Thirty-eight endarterectomies were performed in 32 patients (1.18 endarterectomies/patient) as 15.62% of the patients required multiple endarterectomies. Of the 38 endarterectomies, 78.95% were performed in the left coronary arteries and 21.05% were performed in the right coronary branches. The anterior interventricular branch was grafted in 90.6% of the cases with the left internal thoracic artery (LITA), however In our study Of the 62 endarterectomies, 31 endarterectomies (50.0%) were performed in the right coronary artery and 15 endarterectomies (24.2%) were done on left anterior descending artery followed by 6.5%,3.2%,1.6% in obtuse marginal -II, obtuse marginal -I, Obtuse marginal -III respectively.

In a study done by sakakibara et al The mean patient age was 65.95 year and 200 patients (85.8%) were male. The mean number of distal anastomoses was 4.5 +/-1.3, and the mean length of the incision on the LAD was 6.1+/- 1.7 cm. Two hundred thirty-two patients (99.6%) underwent surgery with an off-pump procedure, and 16 (6.9%) required on-pump conversion. Postoperatively, stroke occurred in 8 patients (3.4%), and deep sternal wound infection was seen in 5 patients (2.3%). Operative mortality was 0.9% (2 of 233) and in our study mean age of the patient was 68 years , mean cross clamp time 73.3 +/- 31 min, mean CPB time 119 +/-40 min, mean ventilation hours 15+/-2 hours, mean Hospital stay in days 10 + /-4 days ,mean ICU stays in days - 5 days .The post operative mortality and incidence of stroke are similar in both the studies.

Thromboprophylaxis plays a central role in the medical management of CE patients. There is a general consensus that all patients need single or double antiplatelet

treatment which can be accompanied by anticoagulation treatment as well. It is worth mentioning that after reviewing relevant guidelines, such as the 'Secondary prevention in the clinical management of patients with cardiovascular diseases' published in 2014 by the European Association for Cardiovascular Prevention and Rehabilitation and the 'Appropriateness Criteria for Coronary Revascularisation' report by the American College of Cardiology Foundation published in 2009, we did not identify any recommendations on anticoagulation and platelet inhibition in patients undergoing CE .However all of our patients were on anti-coagulations and antiplatelet medications.

The better long-term survival and lower incidence of MACCE observed in our study compared to so many other studies could be attributed to the anticoagulation regime we follow and compliance of the patients. We observed in our review that CE is feasible and is a good surgical option when only CABG is insufficient to provide complete myocardial revascularization. However, proper use of anticoagulant and antiplatelet agent in early post-operative period carries better graft patency rate following CE with CABG.

As far as the number of endarterectomised vessels is concerned, it is reasonable that the more vessels are endarterectomised, the higher the probability of serious complications, such as intra- and post-operative MI and mortality [158].

According to Soylu et al., the MI and mortality rates appeared to be increased in patients who underwent CE compared to patients who underwent CABG alone. However, as clarified by the authors, there was limited evidence to support this finding, as there was significant heterogeneity between the included studies. We haven't looked into these aspects or compared the mortality between CABG with CE and CABG alone groups.

Additionally, patients who undergo CE tended to have more severe CAD. Furthermore, there are no double-blinded randomized controlled trials to date that have properly investigated this issue

The management of the CE patient is not only determined by the patients' symptoms and complications. Of equal significance, is the input from a multidisciplinary team,

also known as the 'Heart Team', which includes cardiologists, both interventional and non- invasive, as well as cardiac surgeons. The team can be enriched by the input from additional related specialties and disciplines involved in the patient management. The Heart Team should hold regular meetings in order to discuss the diagnostic findings and management plan on a bespoke basis according to the clinical condition of each patient. In fact, the concept of the Heart Team is included in European and American guidelines for the management of CAD as a class 1C recommendation.

In recent years, a major challenge of the Heart team has been the dilemma between choosing surgical and percutaneous CE, including different modes of the latter. Percutaneous transluminal coronary rotational atherectomy (PTCRA) is a form of CE that can be performed as an alternative to, or in conjunction with, balloon angioplasty A Cochrane review article was published in 2003, and updated in 2012 , assessing the effectiveness of the technique in patients with non-complex and complex lesions (including those arising from in-stent re-stenosis).

In a previous study, Schaff et al. observed that inadequate myocardial revascularization appeared to be the most critical component influencing perioperative outcome, ventricular function, early and late post-operative morbidity and mortality. Although LAD endarterectomy is thought to be more hazardous than other territory, complete revascularization of the LAD is considered a crucial determinant of the post-operative patient's recovery. In our study, approximately 15 patients 24.2% of the CE was performed in the left coronary territory with satisfactory outcome.

CONCLUSION

In the recent decades, the treatment of older patients with diffuse CAD, alongside multiple comorbidities and high expectations for successful treatment, has become a real challenge. CE is a surgical method that can provide acceptably effective and safe results in the treatment of CAD.

CE as an adjunct to CABG, has a significant role in achieving adequate revascularisation and in improvement of long-term outcomes.

In our study the survival rate at 1 year,5 year, and 10 year was 98.4%,96.5% and 81.4% respectively.

LIMITATIONS

As the study is retrospective lapses in data recoding can produce error in the results.

Also, Echocardiography parameters may vary between observers producing a confounding factor in the study.

The above study excluded patients who underwent concomitant procedures.

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PATIENT INFORMATION PROFORMA

PATIENT INFORMATION PROFORMA

SUBJECT CODE NO :

AGE

GENDER

PRE OPERATIVE PARAMETERS

RISK FACTORS/COMORBITIES:

Hypertension

Diabetes

Peripheral Arterial disease

Dyslipedemic

Chronic obstructive lung disease

Thyroid dysfunction

Chronic Kidney disease

NYHA FUNCTIONAL CLASS

IMAGING

Echocardiography

- LVEF
- LVIDD
- LVIDS
- RWMA
- VENTRICULAR FUNCTION

ECG-Pre op Rhytm

INTRA OPERATIVE PARAMETERS

ONPUMP/OFFPUMP

Total cardiopulmonary bypass time

Duration of surgery

Ventricular function

Number of grafts

Emergency /elective surgery

LMCA disease

POST OPERATIVE PARAMETERS

Mortality

Myocardial infarction

Second surgery

Angioplasty

Respiratory failure

Renal failure

Anticoagulation regimen

Arterial vs venous conduits

Hospital Stay

Arrythmias

FOLLOW UP

ECG

ECHO

1. Ejection fraction
2. RWMA
3. Left ventricle function
4. PAH

PLAGARISM CHECK

Ouriginal

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Analyzed document	akash.docx (D142696143)
Submitted	8/6/2022 7:40:00 AM
Submitted by	Dr P K Dash
Submitter email	dash@sctimst.ac.in
Similarity	12%
Analysis address	sadh.sctims@analysis.urkund.com

Sources included in the report

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TEN YEAR SURVIVAL OF PATIENTS UNDERGOING
CORONARY ENDARTERECTOMY WITH CORONARY ARTERY BYPASS GRAFTING IN PATIENTS OF CORONARY ARTERY DISEASE
Thesis SubmittedBy
Dr.Joshi Aakash Dinesh
InPartial Fulfillment oftheRequirement fortheDegreeOfMCh in Cardio Vascular and Thoracic Surgery2020-2022 Underthe guidance of
Dr. Vivek V Pillai Professor
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DECLARATION
I,Joshi Aakash Dineshherebydeclarethatthisthesistitled"TEN YEAR SURVIVAL OF PATIENTS UNDERGOING
CORONARY ENDARTERECTOMY WITH CORONARY ARTERY BYPASS GRAFTING IN PATIENTS OF CORONARY ARTERY DISEASE
"
has been preparedby me under the capable supervision and guidance of Dr Vivek V Dr.VivekVPillai,Professor ,DepartmentofCardiovascularandThoracic Surgery, Sree ChitraTirunalInstituteforMed
Sciences &Technology,Thiruvananthapuram.
Thiruvananthapuram Date:
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Department of CVTS SCTIMST
CERTIFICATE
We hereby certify that this thesis titled "TEN YEAR SURVIVALOF PATIENTS UNDERGOING CORONARYENDARTERECTOMY WITH CORONARY ARTERY BYPASS GRAFTING IN PATIENTS OF CORC
ARTERY DISEASE
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Hehasshownkeeninterestinpreparingthisproject.
Dr.VivekVPillai Professor Department of Cardiovascular and Thoracic Surgery SCTIMST Thiruvananthapuram
CERTIFICATE
I hereby certify that this thesis titled "TEN YEAR SURVIVAL OF PATIENTS UNDERGOING
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isthebonafiderecordofworkdonebyDr.JoshiAakash Dinesh,MChCVTSresident,doneatDepartmentofCardiovascular and Thoracic surgery at Sree Chitra Tirunal Institute forMedicalSciences
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Thiruvanathapuram
Dr.Joshi Aakash Dinesh
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ACKNOWLEDGEMENT
Writing this thesis has been fascinating and extremely rewarding. I would like tothank a number of people who have contributed to the final result in many differentways.
An ostentatious use of words will not be sufficient to express my heartiest thankstomyguideDr.VivekVPillaiProfessor
DepartmentofCardiovascularandThoracicSurgery,SCTIMST,Thiruvananthapuram.Theirvaluableandcriticalsuggestions,constantinspirationandencouragement,instinctivecorrectivemeasures,timele
unstinted cooperation and mental support throughout have made this marathon taska smooth journey.
I will always remain obliged and grateful to my senior professor Dr. JayakumarK and professor & HOD Dr. Baiju S Dharan for his inspiration and support. I have tomention thanks to my Consultar
Sabarinath Menon, Dr. Varghese T Paniker,Dr.SudipDattaBaruah,Dr.SowmyaRemanan,Dr.ShivanesanPitchaiandDr. Renjith S, Dr Simon, whohas been instrumental and constantly
supportedmeduringthecourse.

श्री चित्रा तिरुनाल आयुर्विज्ञान और प्रौद्योगिकी संस्थान, त्रिवेन्द्रम
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Institutional Ethics Committee

(IEC Regn No. ECR/189/Inst/KL/2013/RR-21)

SCT/IEC/1885/MAY/2022 12.08.2022

Dr. Joshi Aakash Dinesh
Senior Resident
Department of CVTS
SCTIMST, Thiruvananthapuram

Dear Dr. Joshi Aakash Dinesh,

The Institutional Ethics Committee held on 13th May, 2022, reviewed and discussed your application to conduct the study titled " **OUTCOMES OF CORONARY ENDARTERTECTOMY IN PATIENTS UNDERGOING CORONARY ARTERY BYPASS GRAFTING FOR CORONARY ARTERY DISEASE – A RETROSPECTIVE STUDY"** (IEC/1885).

The following members of the Ethics Sub-committee were present at the meeting held on 13th May, 2022.

SL. No.	Member Name	Highest Degree	Gender	Scientific /Non Scientific	Affiliation with Institution(s)
1.	Dr. Pradeep S	MBBS, MD	Male	Basic Medical Scientist	No
2.	Smt. Sathi Nair	MA (English Literature)	Female	Lay Person	No
3.	Dr. Christina George	MD Psychiatry	Female	Clinician	No
4.	Dr. P. Manickam	BSMS, MSc (Epid).,PhD	Male	Health Science Expert/ Social Scientist	No
5.	Adv. Priya Kaimal	LLM, MBL	Female	Legal Expert	No
6.	Dr. Manikandan.S	MBBS,MD,PDCC	Male	Clinician	Yes
7.	Dr. Srinivas G	PhD	Male	Basic Medical Scientist (Member Secretary)	Yes

SCT/IEC/1885/MAY-2022

The following documents were reviewed:

Original submission

1. *Covering letter addressed to the Chairperson, IEC, SCTIMST dated 29.12.2021*
2. *TAC Application Form*
3. *Dean's signature form*
4. *IEC Application form*
5. *Declaration form*
6. *Telephone script in Malayalam*
1. *Project Proposal*
2. *Patient Information Proforma*
3. *CV of PI and Co-PIs*
4. *Declaration form*
5. *Checklist Form*
6. *SRC Recommendation Letter*

Revised submission

1. *Covering letter addressed to the Chairperson, IEC, SCTIMST*
2. *TAC Application Form*
3. *IEC Application form*
4. *Declaration form*
5. *Telephone script in Malayalam*
6. *Project Proposal*
7. *Patient Information Proforma*
8. *CV of PI and Co-PIs*
9. *Declaration form*
10. *Patient Information Proforma*
11. *Checklist Form*

IEC Decision

The IEC approved the conduct of the study in the present form.

Remarks:
The Institutional Ethics Committee expects to be informed about the progress of the study, any SAE occurring in the course of the study, any changes in the protocol and patient information/informed consent and asks to be provided a copy of the final report.

There was no member of the study team who participated in voting / decision making process. The ethics committee is organized and operated according to the requirements of Good Clinical Practice and the requirements of the Indian Council of Medical Research (ICMR).

Sincerely,

Dr. G. Srinivas
Member Secretary, IEC

SREE CHITRA TIRUNAL INSTITUTE FOR MEDICAL SCIENCES & TECHNOLOGY
INSTITUTIONAL ETHICS COMMITTEE (IEC)
SCTIMST
THIRUVANANTHAPURAM

MEMBER SECRETARY
INSTITUTIONAL ETHICS COMMITTEE (IEC)
SCTIMST, THIRUVANANTHAPURAM

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