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Coronary Artery Bypass Grafting With Additional Procedures

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ABSTRACT

Coronary Artery Bypass Grafting (CABG) is a usual procedure to treat patients with coronary artery disease with relatively low mortality rates in best centers. The need for additional procedures further increases the risks.

Objectives: The objectives of this study is to present our humble experience with such procedures, to alleviate both doctor and patients concern when needing such an intervention.

Methods: This is a retrospective clinical case series study of patients admitted to Mosul center for cardiology and cardiac surgery from 13-5-2012 till 1-5-2016.

Results: Off all patients referred for CABG, 13.4% needed an additional procedure including LV aneurysm repair, AVR, MVR, DVR and aortic aneurysm repair. Male to female ratio was 3.8:1, 89.6% of patients were in NYHA class 3, 37.9% of patients were diabetic, 65.5% had a reduced EF%, 65.5% had associated respiratory problems and 13.8% had renal impairment. 44.8% needed three coronary grafts, 27.6% needed two grafts, 20.7% needed a single graft and 6.9% needed four grafts. Our median aortic cross clamps was 68.1 min, and our median perfusion time was 113.6 min. Post-operative complications included arrhythmias in 44.8%, prolonged hospital stay in 34.5%, increased postoperative serum creatinine in 27.6%, prolonged mechanical ventilation in 17.2%, prolonged ICU stay in 17.2%, oliguria in 13.8%, low cardiac output in 6.9%, bleeding in 3.4%, with a mortality of 3.4%.

Conclusion: CABG with additional procedures is a safe and common surgical condition with risks and complications comparable to that of CABG alone. More interest should be paid on patient and doctor education on the benefit of proper timing of surgery. And our surgical teams need further training and education to try and further shorten our operative time.

Keywords: CABG, Coronary Artery Bypass Grafting, MVR, Mitral Valve Replacement, AVR, Aortic Valve Replacement, Double Valve Replacement, DVR, LV Aneurysmal Repair.

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INTRODUCTION

Coronary Artery Bypass Grafting (CABG) is a usual procedure to treat patients with coronary artery disease with relatively low mortality rates in best centers. The need for additional procedures further increases the risk.

Open heart surgery is a relatively new field in my city and there is a lot of apprehension and hesitation from both our fellow physicians and patients so this study is to present our humble experience with such procedures, to alleviate both doctor and patients concern when needing such an intervention.

Historical Aspect of CABG

Surgical attempts at increasing blood flow to the ischemic myocardium originated a century ago (exactly at 1910) by Alexis Carrel, for which he was later awarded the Nobel prize At 1946, Vineberg started implanting the LIMA directly into a tunnel made in the LV, Later on, in 1956, Charles Bailey performed successful human coronary endarterectomies in seven patients.

On October 30, 1958, Mason Sones injected dye contrast into the right coronary artery (RCA) of a young man with rheumatic heart disease, which led to the birth of coronary angiography, a truly landmark achievement in the history of cardiovascular care.

On May 2, 1960, Goetz and his team anastomosed the right internal mammary artery (RIMA) to the RCA using Rosenak (tantalum) rings.

The first clinical case of a direct hand-sewn coronary anastomosis was performed by David Sabiston on April 4, 1962, when he anastomosed the saphenous vein graft (SVG) to the RCA at Johns Hopkins.

The Russian surgeon Vasilii I. Kolessov, was the first to report a suture of the RIMA to the RCA without cardiopulmonary bypass on February 25, 1964.

At May 1967 Rene Favaloro introduced the first reversed SVG graft for coronary artery bypass

In 1965 Dr. George Green performed the first LIMA to LAD anastomosis, which has become the gold standard of almost all CABG surgeries. The CABG surgery as it is known today was born! [1-6]

PATIENTS AND METHODS

This is a retrospective case series study conducted in Mosul Center for Cardiology and Cardiac Surgery (MCCCS), cardiac surgery department from the 13th of May 2012 till the first of May 2016.

All patients who were referred to open heart surgery and found to have an ischemic heart disease needing coronary artery bypass grafting in addition to another cardiac surgical

problem also needing surgical correction were included in our study.
Patients with mild valvular diseases or small asymptomatic or non-significant aneurysms not requiring surgical intervention were excluded from the study.

1) Sex Distribution

The total number of patients referred to our unit for CABG was 580.

The total number of patients who underwent CABG whether alone or with another procedure was 216 patients.
Of these 216 patients, 29 needed an additional procedure. This constituted 13.4% of the total number. Of these 23 were males (10.6%) and 6 were females (2.8%). So the male to female ratio was 3.8:1. As shown in figure (1).

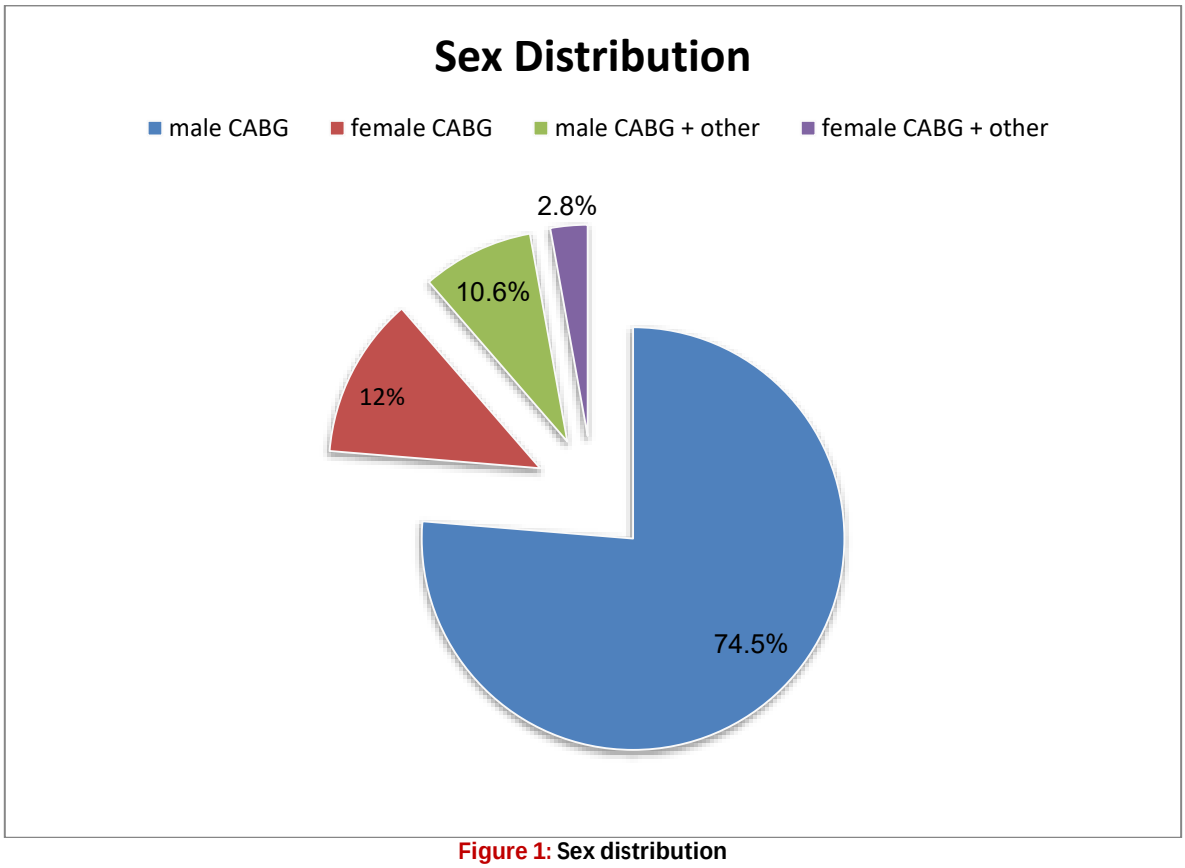

Figure 1: Sex distribution

2) Age Distribution

Our patients' age ranged from 42 - 69 years old. With a mean of 55.7 years of age.
The male patient age ranged from 42 – 63 years with a mean of 55.0 years. While our female patients age ranged from 50 – 69 years with a mean of 57.8 years.

3) Patient Presentation

Patients were categorized according to their presenting complain whether it was related to myocardial ischemia or related the valvular or aneurysmal problem. As shown in figure (2)

The data was taken from patient case sheets as documented by our resident doctors and therefore divided into two categories

1- Patients with features of myocardial ischemia in the form of repeated attacks of chest pain relieved or made less severe by glycerin trinitrate sublingually
2- Patients with features of heart failure in the form of exertional dyspnea, orthopnea and/or leg edema needing continuous use of diuretics

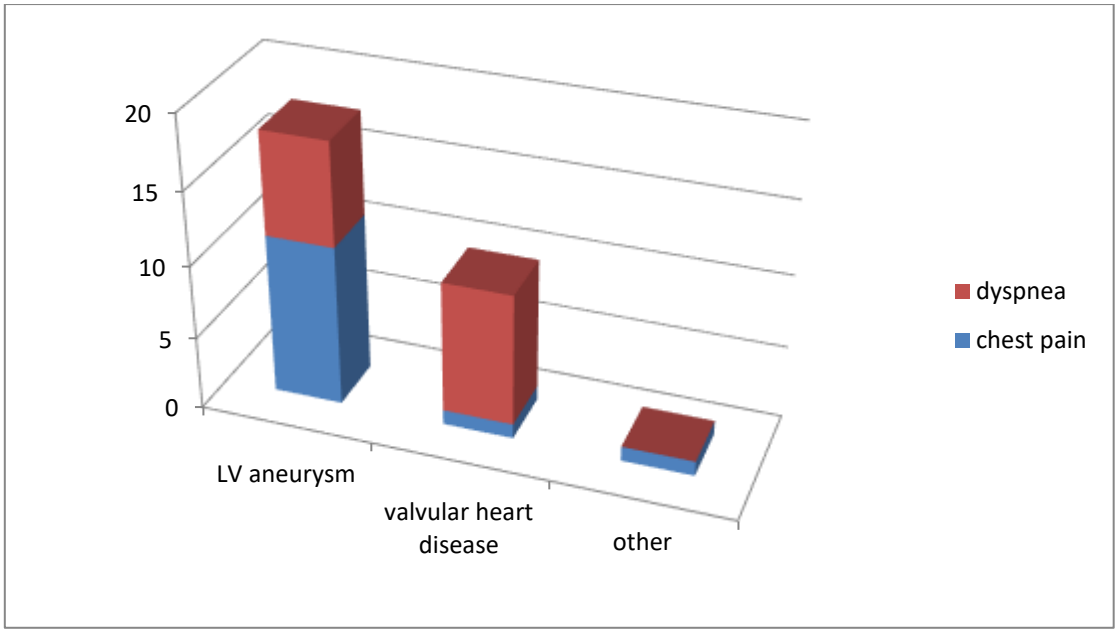

Figure 2: **Patient presentation**

4) Preoperative Status

The preoperative problems which were likely to affect the outcome of our surgical procedure were considered, this included

1) Diabetes mellitus
2) Heart failure (in the form of ejection fraction percent)
3) Respiratory problems and
4) Renal problems

Number of patients with DM 11 / 29
Number of patients with reduced EF% 19 / 29
Number of patients with respiratory problems 19 / 29
Number of patients with renal impairment 4 / 29
Number of patients with 2 or more comorbidities 18 / 29 (11 had 2 comorbidities while 7 had 3 comorbidities and none had more than 3 comorbidities)

5) The Surgical Procedure

The additional procedures - figure (3) - included;

1. Left ventricular aneurysm repair: 17 patients
2. Mitral valve replacement: 7 patients
3. Aortic valve replacement: 2 patients
4. Double valve replacement (mitral and aortic): 2 patient
5. Aortic arch replacement : 1 patient

Of these patients:

a- 13 patients needed CABG x 3
b- 8 patients needed CABG x 2
c- 6 Patients needed CABG x 1
d- 2 patients needed CABG x 4

In other words, an average of 2.4 grafts per patient was needed. As shown in figure (4)

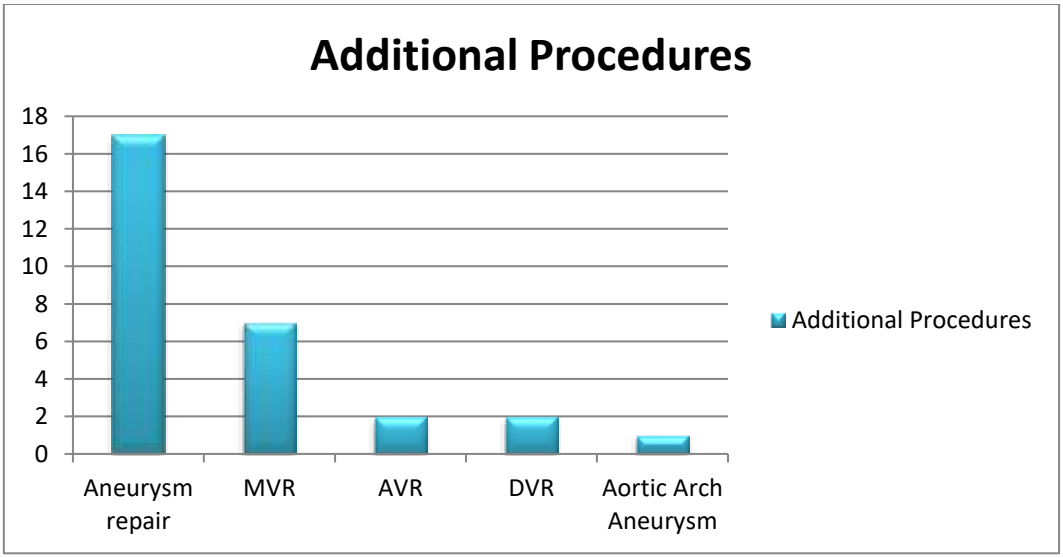

Figure 3: **Additional procedures required**

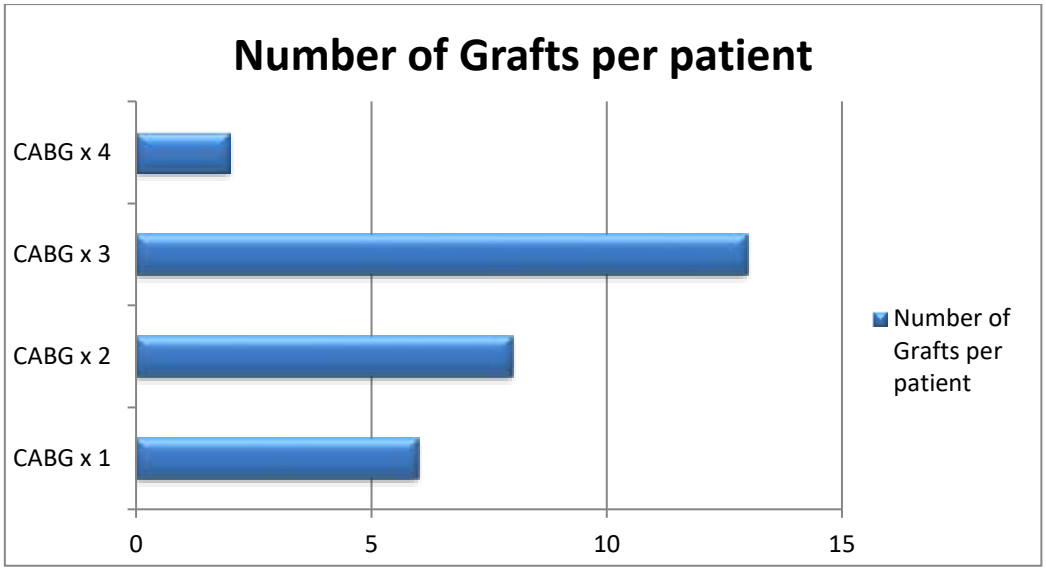

Figure 4: **Number of grafts per patient**

6) Aortic Cross Clamp, and Bypass Time

Perfusion time or also called cardiopulmonary bypass time or bypass time refers to the time from when the cardiopulmonary bypass machine starts to take over the heart and lung function till they regain their function after weaning the patient gradually off the bypass machine. While aortic cross clamp time starts after the cardiopulmonary bypass machine has taken over the heart and lung function, once the surgeon applies a hemostatic clamp to the ascending aorta therefore separating the heart from the circulation and so for cutting off blood supply to the coronary circulation (usually followed by cardioplegic arrest). The cross clamp time end once the clamp is released, so blood is restored to the coronary circulation and the heart starts beating again. Both bypass times and cross clamp times are independent risk factors during all open heart surgery and all attempts are directed to reducing these times to the shortest possible.

The average cross-clamp time for patients needing isolated CABG x1, x2, x3, and x4 alone was about 16.3, 34.5, 43.8, 57.8 minutes respectfully and the mean perfusion time was 49, 61.6, 76.1 and 104.9 minutes respectfully. In the need of an additional procedure all times significantly increased

Most of our coronary re-vasculization was through a conventional CABG (99.1%). Only 2 patients underwent OP-CAB (off pump coronary artery bypass) (0.9%)

On average the need for an additional LV aneurysm repair increased all time by about 17.7 Minutes (ranging from 6.2 - 42.2 minutes)

The need for an additional MVR increased all times by about 40.8 Minutes (ranging from 31.7 - 47.2 minutes)

The need for an additional AVR increased all times by about 58.9 Minutes (ranging from 56.2 - 61.7 minutes)

The need for an additional DVR increased all times by about 66.2 Minutes (ranging from 62.5 – 70.5 minutes)

Overall speaking our average cross clamp time was 68.75 min (ranging from 34 -105 minutes) and the average bypass time was 113.65 minutes (ranging from 50 – 197 minutes).

7) Postoperative Complications

Postoperative complication – as shown in figure (5) - was assessed according to the following data

1- Time of weaning from mechanical ventilator and extubation measured in hours from arriving to the intensive care unit. Most patients were usually extubated within 3-5 hours from arriving to the ICU. So prolonged mechanical ventilation referred to those needing mechanical ventilation for more than 12 hours after reaching the ICU.
2- The need for re-exploration for surgical bleeding
3- The need for inotropes or other cardiac assistance (e.g. ; IABP) measured in hours from arrival at the ICU, some patients need inotropic support for the first few hours only, those who needed inotropic support for more than 6 hours postoperatively where considered needing prolonged inotropic support.
4- The number of days the patient stays in the ICU (intensive care unit) knowing that the baseline stay in the ICU in our hospital for any patient with whatever open heart surgery was 2 days. So any patient who needed to be kept in the ICU for longer than 2 days was considered to have a prolonged ICU stay.
5- The overall number of days the patient remained in hospital. The average hospitalization for all cardiac surgical patients ranged from 5-7 days including 2 days in the ICU with 3-5 days in the surgical ward. So any patients who needed to be kept in hospital for more than 7 days was considered needing a prolonged hospital stay.

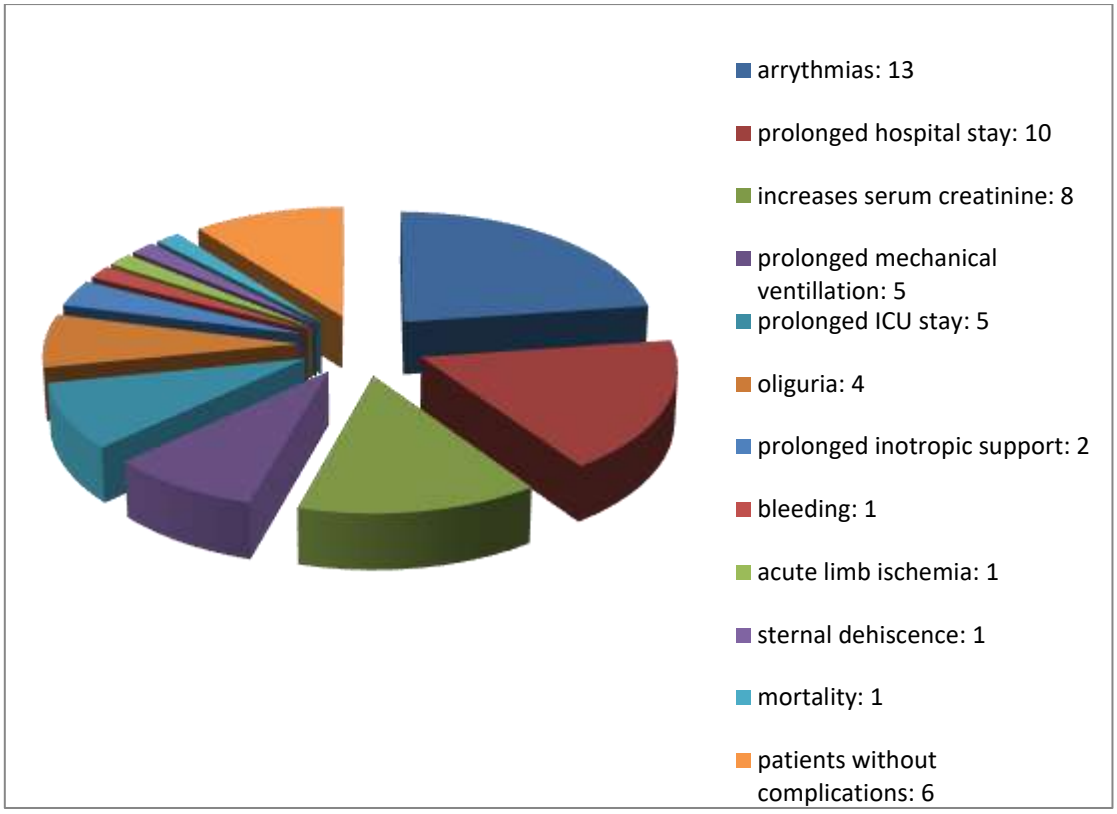

Figure 5: Postoperative complications

Postoperative complications of conventional CABG (CABG without additional procedures) was as shown below.

1-	Prolonged hospital stay	58 patients	31 %
2-	Arrhythmias	36 patients	19.2 %
3-	Prolonged ICU stay	18 patients	9.6 %
4-	Prolonged mechanical ventilation	16 patients	8.5 %
5-	Elevated serum creatinine	13 patients	6.9 %
6-	Prolonged inotropic support	12 patients	6.4 %
7-	Mortality	9 patients	4.8 %
8-	Bleeding	4 patients	2.1 %
9-	Wound infection	4 patients	2.1 %
10-	MI	1 patient	0.5 %
11-	CVA	1 patient	0.5 %

RESULTS AND DISCUSSION

The most common open heart surgery done in our humble center was CABG (coronary artery bypass grafting). 29 of these needed an additional procedure constituting 13.4% of all CABG surgeries. In a similar study [7], the need for additional procedures constituted only 6.4%.

In another study, [8], the need for aneurysm repair with CABG constituted 2.8% of all patients referred for CABG. In our center CABG with aneurysmal repair constituted 7.8% which is also higher than in that study.

May be because open heart surgery is still new in our city and still some doctors are hesitant to refer patients for open heart surgery so our pool of CABG patients is still small if compared to other centers and actually when we looked to the number the average CABG patients referred to those centers, it was around 200 per year while in our center it was around 50 per year. So probably we are only receiving the very ill patients and frankly speaking all our patients were in NYHA class 3.

Concerning the male to female distribution, in our study the male to female ratio was 3.8:1 and in [8], the male to female ratio was 2.8:1, which can be considered close to our study, while in [7] the male to female ratio was 7.8:1. All other studies also show a higher occurrence in male population.

Concerning the clinical presentation, most patients were presented with exertional dyspnea and decreased daily performance as most were in class 3 HYHA classification. Only one of our patients was in the NYHA class 2 and 2 were in class 4 NYHA classification. This is similar to [8], as dyspnea was found in 81% of patients and chest pain in 48% of patients. However this differs from [7], were there patients were mainly in NYHA class 2 (46.2%) and less commonly in class 3 (32.7%) and only 11.7% were in NYHA class 4. so our mean NYHA class was 3.03 while the mean NYHA score in [7] was 2.46. probably this can be explained also by the fact that our patients are still being referred late to surgery.

Concerning preoperative morbidity; 37.9% of our patients were diabetic, 65.5% had a reduced EF% (below 50%) although only 10.3% had an EF% below 36%. 65.5% had associated respiratory problems and 13.7% had some form of renal impairment. When comparing with [7] we found that our patients had a higher percentage for DM (37.9%) compared to 26.9% in [7]. While when comparing the EF%, our patients had a higher mean EF%.

Concerning the surgical procedure; most of our patients needed three coronary grafts (44.8%) while 27.6% needed 2 grafts, 20.7% needed a single graft and only 6.9% needed four coronary grafts. In [8], 81% of patients needed 3 grafts while only 19% needed 2 grafts while none needed more or less. This differs probably because [8] only included LV aneurysms and if we are to take out all non LV aneurysm cases the percentage of patients who needed three grafts will be 64.7%, two grafts 11.8%, four grafts 11.8% and a single graft in only 5.9%, making our mean grafts per patient 2.7 which is comparable to [8] were it was 3.0 grafts per patient.

Concerning the aortic cross clamp time and the perfusion time; our median aortic cross clamps was 68.1 min (with the shortest being 34 min, and the longest being 105 min). Our average perfusion time was 113.6 min (with the longest being 197 min, and the shortest being 50 min)

In a similar study, [9], the average cross clamp time was 90 min which was slightly longer than our cross clamp time. this study only discussed valvular surgery with CABG and if we were to do the same by excluding all non valvular surgery from our calculation we will still have an average cross clamp time of 75.4 min and a bypass or perfusion time of 115.6 min which are both still shorter

In another study, [10], aortic cross clamp time was 148.9 min and bypass or perfusion time was 187 min which was also longer than our times both.

In another study, [11], the bypass time was about 108±28 min which was close to our results.

In [8], the mean cross clamp time was 56.55 minutes and mean perfusion time as 102.61 minutes which was shorter than our times although the study included only CABG with aneurysmal repair and if we are to include only the LV aneurysm cases our cross clamp time and perfusion time would be 62.29 and 110.82 minutes respectfully which are comparable to that study although still slightly longer.

Concerning the post-operative complications; the most common complications we faced were

1-	Arrhythmias;	13 patients representing 44.8%
2-	Prolonged hospital stay	10 patients representing 34.5%
3-	Increased postop serum creatinine	8 patients (27.6%)
4-	Prolonged mechanical ventilation	5 patients (17.2%)
5-	Prolonged ICU stay	5 patients (17.2%)
6-	Oliguria	4 patients (13.8%)
7-	Prolonged inotropic support	2 patients (6.9%)
8-	Bleeding	1 patient (3.4%)
9-	Mortality	1 patient (3.4%)
10-	Acute limb ischemia	1 patient (3.4%)
11-	Sternal dehiscence	1 patient (3.4%)

Arrhythmias were the most common complication encountered postoperatively, with AF (Atrial fibrillation) being the most common arrhythmia (7 patients) although of these 7 patients, 2 were chronic AF since before surgery. 2 patients developed first degree heart block, 2 developed a supraventricular tachycardia, 2 had multiple premature ventricular ectopics. While only 1 patient had premature atrial ectopics. (some patients had more than one type of arrhythmia).

When comparing these results with [8], we found that reoperation for bleeding was higher in their study 7.4% compared to 3.4% in our study while the incidence of sternal dehiscence was higher in our study 3.4% compared to only 1.8% in [8]. Our ICU and hospital stay was also shorter (2.3 and 8.4 days respectfully) while it was longer (3 and 13 days respectfully) in [8].

When comparing to [9], hypertension was the most common post-operative complication in comparism to arrhythmias in our study. They had a longer mean ICU stay (3 days) and a shorter overall mean hospital stay (7 days) but still both are comparable. Mortality rate was also higher in the [9] (14.5%) compared to 3.4% in our study. However re-sternotomy or reoperation for bleeding was higher in our study (3.4%) compared to [9] (1.8%).

In another study, [12], arrhythmias was also the most common complication post-operatively (being 44.8% in their study and ours), prolonged mechanical ventilation was required in 8.6% of patients compared to 17.2% in our study however, mortality rate was higher in the [12] (6.9%) compared to our study (3.4%).

When comparing the postoperative complications of CABG alone to CABG with additional procedures we found the following; table (1).

Table 1: Postoperative complications of CABG alone and CABG with additional procedures

	CABG with additional procedures	CABG alone
Arrhythmias	44.8 %	19.2 %
Prolonged hospital stay	34.5 %	31 %
Increased serum creatinine	6.9 %	27.6 %
Prolonged ICU stay	17.2 %	9.6 %
Prolonged Mechanical ventilation	17.2 %	8.5 %
Prolonged inotropic	6.9 %	6.4 %

support		
Bleeding	3.4 %	2.1 %
Mortality	3.4 %	4.8 %
Wound infection	3.4 %	2.1 %
CVA	0 %	0.5 %
MI	0 %	0.5 %

Arrhythmias happened almost twice as frequent when needing an additional procedure and those patients also needed a longer ICU stay and a longer time on mechanical ventilation probably because of the longer and slightly more complexity of the surgical procedure but with regard to other postoperative complications, the results were comparable.

CONCLUSION

CABG with additional procedures is a safe and common surgical condition with risks and complications comparable to that of CABG alone.

The results of the surgical department of Mosul Center for Cardiology and Cardiac surgery - despite its young age - are comparable to the world records and quite good.

Most patients referred for surgery were in HYHA class 3 (compared to NYHA class 2 in other studies), indicating that there is a delay in the referral of patients to surgery by our cardiologists and physicians and a general fear in our population from the term "open heart surgery" so we need better patient and doctor education on the risks and benefits of open heart surgery and the benefit of proper timing of surgery.

Our cross clamp time and perfusion time are not bad but still longer than the worlds average times meaning we should try to do our best to shorten these times.

CONFLICT OF INTEREST

None

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