Comparative study between minimally invasive direct coronary artery bypass graft and traditional coronary surgery via sternotomy

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Abstract

Background: There is increasing interest in minimally invasive cardiac surgery coronary artery bypass surgery outcomes as alternative surgical interference to conventional sternotomy. Minimally invasive coronary surgery was preferred due to its lower morbidity and less hospital stay.
Objectives: The purpose of this study is to compare the outcome of minimally invasive coronary artery bypass surgery versus conventional surgery via sternotomy.
Patients and Methods: This study included one hundred patients presented with diagnostic indications for the coronary artery bypass grafting coronary according to coronary angiography results. Patients operated either by minimally invasive or conventional techniques via sternotomy. All patients followed up using Echocardiography parameters that was compared preoperatively and postoperatively within 3 months.
Results: Included patients had mean age (50.6 ±11.5). There was female predominance (66 %). Most of included patients known to be hypertensive as 92% of cases in group A, and 86% of cases in group B. Postoperative echocardiography showed significant difference between both groups as compared with preoperativee values for each group separately.
Conclusion: Comparing open coronary artery bypass surgery and minimally invasive coronary artery bypass approaches, there are similar accepted perioperative outcomes.
Keywords: Coronary artery bypass; Echocardiography; Sternotomy.

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Introduction

Great increasing interest was intended toward the minimally invasive cardiac surgeries. Early return to daily work of the patients and minimizing total cost or more days spent by the patient in the hospital. To minimize the invasiveness of your surgical interference in coronary artery bypass grafting, single small incision would be enough through the appropriate intercostal space **(Liu et al., 2019)**.

Cardiopulmonary bypass in open cardiac surgeries is better to be avoided through another invasive procedure as coronary artery bypass surgery. This procedure needs also median sternotomy as usual surgical access to the pathology in coronary artery system for revascularization through a minimally invasive route **(Birla et al., 2013)**.

Therefore the purpose of this study is to compare the outcome of minimally invasive coronary artery bypass surgery versus conventional sternotomy using single grafting off-pump technique.

Patients and methods

This study included one hundred patients diagnosed for coronary artery bypass grafting coronary depending on coronary angiography results. Lesions involving left anterior descending artery in these patients were also included. Coronary angiography revealed lesions in included patients with two or more vessels stenosis ≥50% in the left main artery and >75% in other target vessels. This study was recruited at National Heart Institute.

For the patient, they give them a chance for early return to normal activities, decrease postoperative pain and to minimize the cost of the total hospital stay. They avert any form of sternotomy, reduce intensive care, minimize the time needed for postoperative ventilation, and reduce postoperative blood product transfusion **(Marin et al., 2017; Kofdis et al., 2009)**.

Left internal thoracic artery is the main artery related to coronary artery bypass graft. An alternative vessel for these operations based on left anterior descending artery, but it could need revascularization for proximal left anterior descending artery disease. Minimally invasive technique could be excellent alternative to sternotomy through a left anterior small thoracotomy**(Holzhey et al., 2008; Al-Ruzzeh et al., 2004)**.

Patients were divided into 2 groups as group A of 50 cases with single graft left internal thoracic artery traditional coronary artery bypass surgery and group B of 50 cases with minimally invasive coronary artery bypass surgery. Postoperative Echo was done within 2 weeks and at 3 months in the follow-up period. This study was conducted under the approval of the Human Ethics Committee of the National Heart Institute over the period of two years. A written consent was taken from all patients.

Included patients were aged from twenty to sixty years old, and patients showed more than 45% for ejection fraction and less than 60 mm for left ventricular end-diastolic

diameter of, without need for surgical treatment of the heart valves or large blood vessels.

Patients who excluded had the following features as cases under emergency status, and any case with severe valve damages. Patients with congenital heart diseases, or patients exhibited severe liver or kidney dysfunction were also excluded from our study.

Collected data from the patients were as the following: before the surgical intervention, evaluation with full history taking and clinical examination was done. History of the present illness, and past history with special concern on known hypertension, diabetes mellitus, or coronary heart diseases were also recorded. Clinical examination including general examination, local cardiothoracic examination was also done to all patients. Imaging studies as electrocardiography, echocardiography and Computed Topography of chest with contrast were performed for all patients. Laboratory investigations were also done as complete blood count, cardiac enzymes, liver function tests, kidney function test, and bleeding profile.

Using general anesthesia and after endotracheal intubation, the main technique of our institute was conventional median sternotomy in supine position under systemic hypothermia. Right hemithorax was elevated in another technique using an inflatable cushion. As shown in (**Fig.1**), an eight cm sub-mammary skin incision as minimally invasive was done; then entering the pleural space should be done to deflate the right lung through the fourth intercostal space. A retractor with long blades was placed and long bade diathermy was used to harvest the right internal thoracic artery. Under stabilizer aid and an intracoronary shunt as shown in (**Fig.2**), the anastomosis was performed after heparinization on a beating heart. Additional grafting of the diagonal or intermediate arteries was achieved as a y-graft, using the right radial artery connected end-to-side to the right internal thoracic artery. Before closing the incision in layers, single chest tube was inserted in right pleura.

When the closure of the incision was finished, immediately local infiltration of 0.25% bupivacaine was done. The amount of needed analgesic was also evaluated. The timing of discharge from the hospital was recorded based on clinical and the patient's physical criteria without consideration of the open coronary artery bypass surgery via sternotomy or minimally invasive coronary artery bypass procedures. Calculation of total operative time, plus intraoperative or postoperative blood loss was done, and the patients who need blood products transfusion.

Calculation of total days spent at the hospital and especially at intensive care unit was calculated. Recording any complications occurred as infection, bleeding, arrhythmias, cerebrovascular accident, myocardial infarction, and thromboembolism was done also. Postoperative

echocardiography was repeated 3 months after the operation. Parameters of the echocardiography were compared between pre and postoperative values.

Fig.1. Minimally invasive chest incision

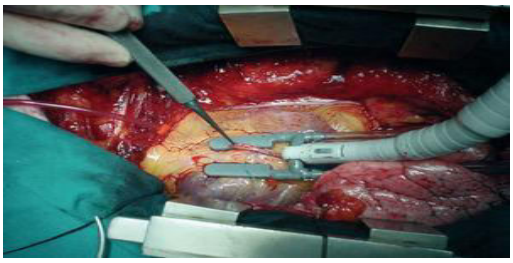

Fig.2. Using stabilizer and inter-coronary shunt

Statistical analysis

All statistical analyses were performed at a 5% confidence interval and a p-value < 0.05 was considered significant. Using certain statistical program was done for statistical analysis(Statistical Package of the Social Sciences 15.0 from Ilinois, United States of America) were used for the analysis of the data. In addition to the standard descriptive statistical calculations as mean, standard deviation, the results on categorical measurements were presented in numbers (%).

Results

The patients' data were summarized at Table (1). Included patients had mean age (50.6 ±11.5). There was 66 % of female predominance. Most of included patients known to be hypertensive as 92% of cases in group A, and 86% of cases in group B. Only 17 cases had history of diabetes in group A compared with 19 cases in group B. Myocardial infection was recorded as a previous event in 24 cases of each group (**Table.1**).

Table 1 Patient characteristics

Variables	**Total No. of patients = 100**	
Age	50.6 ±11.5	
Gender • **Male** • **Female**	44 (44%) 66 (66%)	
History of chronic diseases	**Group A (50 cases)**	**Group B (50 cases)**
Hypertension	46 (92%)	43 (86%)
Diabetes Mellitus	17 (34%)	19 (38%)
Previous Infarction	24 (48%)	24 (48%)

Significant differences were recorded comparing both groups as number of patients had blood transfusion, calculated time for operation, and mean duration of days spent at hospital as shown in (**Table. 2**). No significant difference was recorded comparing both groups as calculated amount of blood loss either intraoperative or postoperative plus calculated days spent at intensive care unit.

(**Table.3**) assessed echocardiographic parameters for included patients comparing preoperative and postoperative values, this showed significant difference between both groups as postoperative values for each group compared with preoperative values.

Table 2: Operative and early postoperative

Variables	Group A	Group B	Test	P-value
Duration of operation	418.8 ± 48.8	373.8 ± 49.2	3.683*	0.015 S
Intraoperative blood loss	408.6 ±48.8	393.4 ± 53.6	1.389*	0.185 NS
Postoperative blood loss	308.4 ± 50.4	273.1 ± 71.8	0.825*	0.088 NS
Blood transfusion	13.6 ± 2.1	12.1 ± 2.6	2.453*	0.027 S
Acetaminophen used (g/d)	1.5 ± 0.7	1.3 ± 0.4	1.464*	0.164 NS
Morphine needed • Yes • No	 28 22	 16 34	8.651**	0.070 NS
Intensive care stay (days)	5 ± 1.5	5.1 ± 1.4	0.398*	0.696 NS
Total hospital stay (days)	11.7 ± 2.2	10.2 ± 2.1	2.969*	0.012 S

*** FOR t-test, ** FOR Chi-square test, NS= Non-Significant, S= Significant**

(**Table .4**) assessed postoperative complications between both groups. Atrial fibrillation was recorded in 12 cases of group A, 5 cases only of group B. Three cases of mortality in group A, 2 of them presented with cardiac arrest in 1st and 4th day postoperative, only one case of both groups presented with severe hemorrhage led to death. Two cases of group A presented with sternal wound infection, and another 2 cases of group A presented with pneumonia. Only one case of group A had pneumonia. Only one case of both groups had renal failure.

Table 3. Pre-and postoperative Echocardiography parameters

Variables	Preoperative	Postoperative (3 months)	t-test	P-value
Group A (EF)	43.2 ± 10.2	49 ± 7.3	2.487	0.026 S
Group B (EF)	41.9 ± 9.4	48.3 ± 6.9	3.025	0.009 S
Group A (EDD)	53.3 ± 3.6	59.7 ± 5.2	2.821	0.012 S
Group B (EDD)	52.4 ± 4.2	61.1 ± 7.1	2.906	0.003 S
Group A (ESD)	41.3 ± 3.4	47.3 ± 3.2	2.321	0.029 S
Group B (ESD)	43.4 ± 2.6	48.4 ± 1.1	2.506	0.034 S

EF: Ejection fraction, EDD: end diastolic dimension, ESD:end systolic dimension, NS= Non-Significant, S= Significant, HS= Highly Significant.

Table 4. Complications

Complications	Group A	Group B
Atrial fibrillation	12	5
Cardiac arrest	2	0
Hemorrhage	3	5
Renal failure	1	1
Wound infection	2	0
Pneumonia	2	1
Mortality	3	1

Discussion

Much research studied new techniques for better results in coronary artery by pass graft operations. Some of them intended to compare the outcomes of minimally invasive cardiac surgery coronary artery bypass versus conventional technique. **Baishyaet al. (2017)** found out that minimally invasive group had significantly lesser intra-operatively blood loss, and longer duration of the surgery. They also had shorter intensive care unit stay, and total hospital stay with fewer amounts of analgesics needed postoperatively. Comparing visual analogue scores

preoperatively and on the day of surgery and 1st postoperative day showed progressive decrease in recorded values. There was no significant difference in total blood amount lost postoperatively, thus there was significant difference in total amount of needed blood transfusion.

Rogers et al. (2013) in a randomized study of 93 patients operated through median sternotomy and anterolateral thoracotomy approaches with off-pump technique. elective coronary artery bypass graft patients undergoing. Duration of surgery was recorded as following (median, 4.1 vs. 3.3 h).days spent at intensive care unit was detected as following (22.4 vs. 23 h). There was similarity in pain scores in both groups as shown in this study. **Baishyaet al.(2017)** showed longer surgery time comparing minimally invasive versus conventional techniques (5.3 vs. 4.5 h), but the total days spent at intensive care unit was as following (1.72 vs. 2.24 days), and total days spent at hospital was as following (4.52 vs. 5.72 days).

One hundred patients were divided to be operated as consecutive minimally invasive direct coronary artery bypass cases or traditional sternotomy coronary artery bypass grafts by **Poston et al. (2008).**They showed that intubation times (4.8 vs. 12.24 h), hospital stay (3.77 vs. 6.38 das) were shorter in minimally invasive group. Similarly, in another study for **Baishya et al.(2017**), hospital stay was shorter. Operation time was compared between open group and minimally invasive group and showed longer time spent in the minimally invasive technique (334 vs. 292 min).

One hundred and fifty sternotomies were done by **Lapierre et al. (2011**) as either minimally invasive technique or off-pump for patients needed coronary artery bypass grafts. There was also less mean of total hospital stay in minimally invasive technique (5.4 vs. 7.2 days).

One hundred and thirty patients were divided to two groups for coronary artery bypass grafts with either technique as minimally invasive or conventional open technique. Four days was the mean postoperative duration spent at hospital in minimally invasive compared with five days in conventional group.

Birla et al.(2013) presented a study comparing minimally invasive approaches and conventional coronary artery bypass grafts, they noted that minimally invasive operated patients needed much more transfusion of blood products. There were also lower days needed to stabilize the general condition at intensive care unit in minimally invasive group (38.4 hours) versus open conventional group (47.8 hours).

As shown in our results, there are higher blood products transfusion requirements in open coronary artery bypass surgery via sternotomy than minimally invasive coronary artery bypass approaches groups. Days calculated as intensive care unit stay were shorter in minimally invasive

group. **Karpuzoglu et al.(2009**) presented study to compare the outcomes of minimally invasive coronary artery bypass grafting versus conventional open technique and noted that minimally invasive group recorded mean of hospital stay as 4.5 days compared with open technique as 5.2 days mean of hospital stay.

Diegler et al. (1999) presented a study of ninety-five matched patients who underwent conventional coronary artery bypass graft with cardiopulmonary bypass, and sixty-five consecutive minimally invasive coronary artery bypass patients using anterolateral thoracotomy approach, off-pump technique. Minimally invasive coronary artery bypass showed lesser pain scores postoperatively especially in the first day. As shown in our results **Baishya et al.(2017**) found out that there is significant decrease of intraoperative blood loss comparing minimally invasive group (365.9 ml) versus conventional technique(519.4 ml).They showed also similar requirements of blood products transfusing events comparing both groups.

Larger sample of patients with wide scope of follow-up parameters is needed in further studies, thus reach the surgeon to the most appropriate technique depending on proper patient selection. Short follow-up duration is mainly the chief limitation of this study.

Conclusion

There are similar accepted perioperative outcomes between traditional coronary artery bypass surgery and minimally invasive coronary artery bypass approaches. There are lowered number of hospital days spent and less need for blood products transfusion in minimally invasive coronary artery bypass surgery.

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