Original Article

Minimally Invasive Compared to Conventional Approach for Coronary Artery bypass Grafting Improves Outcome

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Abstract

Introduction: Minimally invasive (MI) cardiac surgery is a rapidly gaining popularity, globally as well as in India. We aimed to compare the outcome of MI to the conventional approach for coronary artery bypass graft (CABG) surgery. **Methods:** This prospective, comparative study was conducted at a tertiary care cardiac surgical center. All patients who underwent CABG surgery via MI approach (MI group) from July 2015 to December 2015 were enrolled and were compared against same number of EuroSCORE II matched patients undergoing CABG through conventional mid-sternotomy approach (CON group). Demographic, intra- and post-operative variables were collected. **Results:** In MI group, duration of the surgery was significantly longer (P = 0.029). Intraoperative blood loss lesser (P = 0.002), shorter duration of ventilation (P = 0.002), shorter Intensive Care Unit stay (P = 0.004), shorter hospital stay (P = 0.003), lesser postoperative analgesic requirements (P = 0.027), and lower visual analog scale scores on day of surgery (P = 0.032) and 1st postoperative day (P = 0.025). No significant difference in postoperative blood loss, blood transfusion, or duration of inotrope requirement observed. There was no conversion to mid-sternotomy in any patients, 8% of patients had desaturation intraoperatively. There was no operative mortality. **Conclusion:** MI surgery is associated with lesser intraoperative blood loss, better analgesia, and faster recovery.

Keywords: *Minimally invasive direct coronary artery bypass, postoperative analgesia, postoperative outcome*

Introduction

Minimally invasive (MI) approaches to surgical coronary revascularization have gained popularity due to the patient (less tissue trauma, better cosmesis) and economic demands (faster recovery and shorter hospital stay).[1] Studies have compared the MI and conventional approaches (CON) in terms of recovery patterns, long-term survival, and graft patency.[2-5] An accurate comparison is difficult as the cases which are selected for MI approach are usually lower risk patients with better coronary anatomy. We aim to compare patients undergoing coronary artery bypass graft surgery (CABG) via the MI approach to those undergoing via a conventional mid-sternotomy approach. We hypothesized that the duration of hospital stay is lower in MI group.

Methods

This prospective, observational, comparative study was conducted at a tertiary level cardiac center. In view of the observational nature, Institutional Ethical Committee approves the study with waiver of patient consent. All patients who underwent CABG from July 2015 to December 2015 via MI approach (MI group) were included in the study. These patients were chosen by the operating surgeon and patient's informed consent was taken before the procedure. All the patients were operated by a single surgeon. Those with unstable angina or unstable hemodynamic status; complicated coronary anatomy, combined procedures, obese patients, etc., were excluded. Patients were explained about the use of visual analog scale (VAS) during the preoperative visit by the investigator. A similar number of patients undergoing CABG, whose EuroSCORE II values matched the MI cases, via the CON group were selected. This was done to correct for the selection bias inherent in the selection of cases in the MI group. To achieve a power of 80% and an alpha error of 5% a minimum required a sample size of 16 per group was required to obtain a significant result in terms of hospital stay.

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In MI group, lung isolation was achieved with double lumen tube (Portex® Endobronchial Double Lumen tube [Smith Medical, Minnesota, USA]) or bronchial blocker (Copdech Endobronchial blocker tube [Daiken Medical Co., Ltd., Osaka Japan] or Arndt Endobronchial blocker Set [Cook Medical Inc., Bloomington, IN, USA]) only, in the case of lateral thoracotomy approach, whereas they were ventilated using a single lumen tube in case of a sub-xiphoid approach. The position was confirmed by fibre-optic bronchoscope. Injury to the airway during the placement of airway devices, if any, was noted down. The patient was positioned with 15–30° right lateral tilt for thoracotomy approach and with a wedge under the chest for subxiphoid approach. One-lung ventilation was initiated during internal mammary artery harvesting.

Rultract (for thoracotomy approach) and throexpo (for sub-xiphoid approach) retractor systems (Medtronic, 710, Medtronic Parkway Minneapolis, Minnesota, 55432-5604, USA) were used. Proximal and distal anastomoses were performed using standard techniques.

Hypotension (defined as mean arterial pressure decrease of more than 30% of preoperative value) was treated using a combination of either intravenous lactated Ringer's solution, and/or Trendelenburg's position and/or intravenous infusion of noradrenaline (0.01-0.05 mcg/kg/min). A transfusion trigger of 8 g/dl was used, and RBC concentrates were administered. Intraoperative events such as conversion to midsternotomy or institution of cardiopulmonary bypass, blood or product transfusion were also noted. Intravenous fluids and inotropes were adjusted according to the hemodynamics. Patients were extubated when extubation criteria (awake pain-free patient without arrhythmias, bleeding, or low cardiac output) were met. Postoperative analgesia was administered using thrice daily regimen of 5 mg subcutaneous morphine and breakthrough pain was treated with aliquots of 50 mcg of Fentanyl. Patients were followed-up till discharge from the hospital. A detailed description of the institutional protocols is given elsewhere.[6]

Statistical analysis

Continuous data were described as mean ± standard deviation and categorical data as number (%). Data were assessed for normality using Shapiro–Wilk test. Comparisons of means were done using independent sample *t*-test. The value of $P < 0.05$ was considered statistically significant. R for Statistics (3.1.1) (R Foundation for Statistical Computing, Vienna, Austria) was used for analysis.

Results

Twenty-five patients who underwent MI were enrolled (16 via anterolateral thoracotomy approach and 9 via sub-xiphoid approach). From 262 patients who underwent conventional CABG, operated by the same surgical team, 25 EuroSCORE II matched patients were selected.

The comparison between intraoperative and postoperative variables is given in Table 1.

In MI group, there was no incidence of airway injury or conversion to mid-sternotomy. Eight percent patients had desaturation during one-lung ventilation, and one patient needed change from one-lung to two-lung ventilation. There was no intraoperative mortality. The median number of grafts in MI group was 1 compared to 4 in CON group. Duration of the surgery was significantly longer in MI group (334.4 ± 76.12 vs. 292.8 ± 52.5 h, $P = 0.029$). MI group had significantly lesser intra-operatively blood loss (365.92 ± 156.84 vs. 519.44 ± 171.86 ml, $P = 0.002$), shorter duration of ventilation (240 ± 193.68 vs. 495 ± 333.4 h, $P = 0.002$), shorter Intensive Care Unit (ICU) stay (1.72 ± 0.54 vs. 2.24 ± 0.66 days, $P = 0.004$), shorter hospital stay (4.52 ± 1.27 vs. 5.72 ± 1.4 days, $P = 0.003$), lesser postoperative intravenous Fentanyl requirements (97.22 ± 25.57 vs. 123.91 ± 47.36 micrograms, $P = 0.027$), and lower VAS scores on day of surgery (3.08 ± 1.15 vs. 3.79 ± 1.1, $P = 0.032$) and 1st postoperative day (2.04 ± 1.10 vs. 2.72 ± 0.98, $P = 0.025$). There was no significant difference in postoperative blood loss, blood transfusion, or duration of inotrope infusion.

Discussion

In this study, MI group had significantly longer duration of the surgery, lesser intra-operatively blood loss, shorter duration of ventilation, shorter ICU stay, shorter hospital stay, lesser postoperative analgesic requirements, and lower VAS scores on the day of surgery and 1st postoperative day. There was no significant difference in postoperative blood loss, allogenic blood transfusion or duration of inotrope infusion.

Rogers *et al*. in a randomized study (STET trial) of 93 elective CABG patients undergoing off-pump revascularization via median sternotomy and anterolateral thoracotomy approaches. They noted a longer duration of surgery (median, 4.1 vs. 3.3 h), shorter intubation time (256 vs. 321 min) and similar ICU stay (22.4 vs. 23 h) in thoracotomy group. Pain scores were similar, although thoracotomy group need more analgesics. In our study, duration of surgery was longer in the MI group (5.3 vs. 4.5 h), but the duration of intubation (240 vs. 495 min), length of ICU (1.72 vs. 2.24 days), and hospital stay (4.52 vs. 5.72 days) were shorter. Analgesic requirements were lesser in MI group (97.22 vs. 123.91 mcg of fentanyl), and VAS scores (3.08 vs. 3.79 on day 0, and 2.04 vs. 2.72 on day 1) were lower.[2]

Lichtenberg *et al*. in a study comparing MI direct coronary artery bypass (MIDCAB) to Conventional CABG, noted shorter operation time (140 vs. 189 min) and duration of ventilation (300 vs. 840 min) in MIDCAB group. Postoperative pain scores were higher in MIDCAB group

Table 1: Comparison of perioperative variables

	MI group		CON group		*P*
	Mean	Standard Deviation	Mean	Standard Deviation	
Duration of surgery (minutes)	334.4	76.1	292.8	52.5	0.029
Intraoperative inotropes used (mcg/kg/min)	0.06	0.04	0.06	0.03	0.76
Duration of ventilation (minutes)	240.00	193.68	495.00	333.44	0.00
Duration of Inotrope use (minutes)	314.20	220.98	362.40	324.91	0.54
Intraoperative blood loss (ml)	365.92	156.84	519.44	171.86	0.00
Postoperative blood loss (ml)	326.25	184.72	328.28	218.40	0.97
Postoperative fentanyl used (mcg)	97.22	25.57	123.91	47.36	0.04
Postoperative paracetamol used (g)	1.40	0.71	1.60	0.76	0.34
Visual analogue score on POD 0	3.08	1.15	3.79	1.10	0.03
Visual analogue score on POD 1	2.04	1.10	2.72	0.98	0.03
Visual analogue score on POD 2	1.40	1.15	1.72	0.84	0.27
Time to mobilize (hours)	17.12	3.40	18.44	5.15	0.29
ICU length of stay (days)	1.72	0.54	2.24	0.66	0.00
Ward length of stay (days)	2.80	0.87	3.48	1.00	0.01
Hospital length of stay (days)	4.52	1.26	5.72	1.40	0.00
	Median	Range	Median	Range	
Use of allogenic blood products	0	0-2	0	0-2	0.14

POD: Postoperative day; ICU: Intensive care unit

(5.5 vs. 3.6 on day 1 and 4 vs. 2.9 on day 3).[3] In this study, MI group had longer operating time (334 vs. 292 min) but had shorter duration of ventilation (240 vs. 495 min). Contrary to their findings VAS scores were lower in MIDCAB group in our cohort as noted earlier.

Poston *et al*. in a comparison of 100 consecutive MI-CABG cases to traditional sternotomy CABGs concluded that intubation times (4.8 vs. 12.24 h), hospital stay (3.77 vs. 6.38 das) were shorter in MI group. Similarly, in our study, the intubation times, as well as hospital stay, was shorter.[7]

In a study by Lapierre *et al*., comparing 150 sternotomy off-pump CABG (OPCABG) to MI, after matching patients according to age, gender, left ventricular function, and number of distal anastomoses found hospital stay (5.4 vs. 7.2 days) was lower in MI group.[8] The trend is similar in our study, although the ICU stay was shorter even in the conventional group.

In another study, Rabindranauth *et al*. studied 130 MI patients who were 2:1 matched to traditional OPCABG patients. Mean postoperative length of stay in MICS group was 4 days vs. 5 days in conventional group. They concluded that MICS was safe and reasonable alternative to conventional CABG.[9] Results of our study indicate a similar trend.

In a study by Birla *et al*. which compared MIDCAB and OPCAB surgeries, they noted 6 (8.6%) conversion to sternotomy, higher transfusion requirements (1.6 vs. 3.2 units) in MIDCAB group. MIDCAB group had shorter duration of ventilation (5.04 vs. 5.35 h) and ICU stay (38.36 vs. 47.87 h).[10] There was no incidence of conversion in our cohort, and transfusion requirements were similar in both groups. Duration of ventilation and ICU stay were shorter, as explained earlier.

In a comparative study of MIDCAB and OPCAB Karpuzoglu *et al*. noted shorter duration of mechanical ventilation (6.8 vs. 8.3 h) and total hospital stay (4.5 vs. 5.2 days), which is similar to our findings.[11]

In a prospective trial of 65 consecutive MIDCAB patients using anterolateral thoracotomy approach, off-pump technique and 95 matched patients who underwent conventional CABG with CPB, postoperative pain was higher in after MIDCAB on POD 1, but they had better pain relief during subsequent days.[12] In our cohort, postoperative pain was consistently lower from the day of surgery into the postoperative period.

The intraoperative blood loss in MI group was significantly lesser (365.92 vs. 519.44 ml), but transfusion requirements were similar in the group. The data on intraoperative transfusion were not collected.

Limitations

Patient selection was not randomized, thus selection bias may exist in MI group, as low-risk patients may have been favored for undergoing MI. We have tried to control by EuroSCORE II based 1:1 matching of patients undergoing CON CABG. Long-term follow-up was not done. Thus, issues related to graft patency and long term event free survival have not been studied.

Conclusion

MICS compared to CON to cardiac surgery is associated with lesser operative blood loss, better analgesia, and faster recovery.

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Conflicts of interest

There are no conflicts of interest.

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