

## ABSTRACT

**Background** Median sternotomy is the gold standard incision for most cardiac operations. However, with the advent of minimal invasive surgery, a new approach emerged in cardiac surgery named mini-sternotomy and has been successfully used to perform a variety of operations.

The aim of this paper is to present our experience of using mini-sternotomy to harvest the left internal mammary artery (LIMA) for off-pump revascularization of the left anterior descending artery (LAD)

**Methodology** Over a 2-year period (October 2012-October 2014), 100 patients underwent coronary artery bypass grafting (CABG) via conventional median sternotomy (CMS) (n=80) and mini-sternotomy (MS) (n=20). The 2 groups were compared regarding length and difficulty of surgery, postoperative pain and respiratory function, stay in the intensive care unit (ICU), wound infection, shoulder stability and other variables.

**Results** One patient (5%) with LMS was converted into CMS due to inadequate exposure. The blood loss was less in LMS patients. Lung atelectasis and pleural effusions were less in

group 2. A higher PaO<sub>2</sub>, lower PaCO<sub>2</sub> and a shorter assisted-ventilation time were observed in LMS group. Early postoperative pain score & analgesic requirements were less in LMS patients and their hospital stay was shorter (4-5 days) than CMS. Moreover, LMS patients could return to their jobs and drove cars earlier than group 2 patients. There were 9 deaths (11.3%) in CMS group vs. one death (5%) in LMS group; however, this difference was not statistically significant (p<0.05)

**Conclusions** This study shows that off-pump coronary surgery through mini-sternotomy incision is feasible and safe.

**Key words:** Median sternotomy, mini-sternotomy, coronary artery bypass grafting, off-pump surgery

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Received at 7/3/2018

Accepted at 3/2/2019

## INTRODUCTION

The heart is securely placed within the mediastinum and guarded by the bony skeleton of thoracic cage made by the sternum and ribs. The traditional and gold standard approach to the heart is median sternotomy<sup>[1]</sup>. This was described for the first time by Milton in 1897 and re-introduced later by Julian in 1957<sup>[2]</sup>. Conventional median sternotomy (CMS) incision has the advantage of being rapidly performed and closed besides providing an ample exposure of the heart. However, it is a big incision associated with known morbidities such as postoperative pain, infection and others<sup>[1]</sup>. Therefore, it was logical to think of a smaller incision that effectively visualize the coronary arteries yet, provides more advantages and fewer complications<sup>[3]</sup>. Mini-sternotomy (MS) was introduced to meet these goals. In this article, we present our initial experience in using lower mini-sternotomy vs. standard

median sternotomy for left internal mammary artery (LIMA) to left anterior descending artery (LAD) bypass in view of the published relevant literature.

## METHODS

Over a 2-year period (October 2012-October 2014), 100 patients underwent coronary artery bypass grafting (CABG) via CMS (Group 1, n=80) and lower mini-sternotomy (LMS) (Group 2, n=20). In group 2, there were 12 males (60%) and 8 females (40%) with an age range from 43-76 years. Patients with single vessel disease with a low ejection fraction (EF) and a medical comorbidity such as chronic obstructive pulmonary disease (COPD) were chosen in Group 2.

CMS was performed following the standard technique<sup>[1]</sup> while the technique of LMS described by Doty et al<sup>[4]</sup> was employed. Conventional instruments were used through

this relatively small incision (Figure 1). In both techniques, LIMA was harvested prior to placement of the self-retaining retractor. The 2 groups were compared regarding length and difficulty of surgery,

postoperative pain and respiratory function, stay in the intensive care unit (ICU), wound infection, shoulder stability and other variables. Z test was used for statistical analysis.



Figure 1: An operative photograph showing LMS approach.

## RESULTS

A comparison between the 2 study groups is shown in **Table 1**.

| Parameter   | CMS (Group 1) | LMS (Group 2)           |
|---|---------------|-------------------------|
| • Surgical exposure                                       | Ample         | Limited                 |
| • Intra-operative complications                           | Nil           | Nil                     |
| • Blood loss  | ↑             | ↓                       |
| • Transfusion   | The same      | The same                |
| • Conversion to full sternotomy                           | -             | One case                |
| • Re-opening for bleeding                                 | The same      | The same                |
| • Early postoperative pain score & analgesic requirements | ↑             | ↓                       |
| • Postoperative ventilator-assisted time                  | ↑             | ↓                       |
| • Prolonged ventilation                                   | ↑             | ↓                       |
| • PaO <sub>2</sub>  | ↓             | ↑                       |
| • PaCO <sub>2</sub> & FiO <sub>2</sub>                    | ↑             | ↓                       |
| • Atelectasis   | ↑             | ↓                       |
| • Pleural effusion & thoracocentesis                      | ↑             | ↓                       |
| • Use of shoulder girdle                                  | Later         | Earlier                 |
| • Return to work  | Later         | Earlier                 |
| • Driving car   | Later         | 2 weeks after operation |
| • Death   | 9/80 (11.3%)  | 1/20 (5%)               |
| No significant difference (p<0.05)                        |               | Due to MI               |

The exposure provided by CMS was better than LMS. One patient (5%) with LMS was converted into CMS due to inadequate exposure. There were no significant intra-operative complications in both groups. Although the blood loss was less in LMS patients, the transfusion requirement was the same in both groups as well as the rate of re-opening for bleeding. Lung atelectasis and pleural effusions were less in group 2. A higher PaO<sub>2</sub>, lower PaCO<sub>2</sub> and a shorter assisted-ventilation time were observed in LMS group. Early postoperative pain score & analgesic requirements were less in LMS patients and their hospital stay was shorter (4-5 days) than CMS. Moreover, LMS patients could return to their jobs and drove cars earlier than group 2 patients. There were 9 deaths (11.3%) in CMS group vs. one death (5%) in LMS group; however, this difference was not statistically significant ( $p < 0.05$ ).

## DISCUSSION

The first open heart operation was performed in 1953. In the subsequent 4 years, cardiac operations used to be done through the painful bilateral anterior thoracotomy approach. To minimize pain as well as other complications, Julian in 1957 re-introduced median sternotomy. Worthy to note that this operation was described for the first time by Milton in 1897 and remained forgotten for almost 60 years [2].

In the last years the population of patients referred for coronary surgery has changed toward a high-risk profile. In high risk patients minimally invasive approach could be a good option to reduce mortality and morbidity. Del et al believe that through a mini-sternotomy approach, single- or double-vessel revascularization can be performed safely off-pump even in high-risk patients without compromising the accuracy of anastomosis [5].

In a very recent study from China, Xiao et al described "a novel method" with amazing results. Complete revascularization of multi-vessel coronary diseases through lower mini-sternotomy on beating hearts was presented. The study enrolled 79 patients

(62 males and 17 females) and lasted for 1 year. Although the procedure was "technically demanding", various sites of distal target vessels could be reached and complete revascularization could be achieved for these "selected" patients [6].

In their paper, Dooley A and Asimakopoulos G tried to get an answer to the clinical question "Does a minimally invasive approach result in better pulmonary function postoperatively when compared with median sternotomy for coronary artery bypass graft?". Through an internet search, the researchers found answers in 8 papers and concluded that "non-randomized studies support the hypothesis that minimally invasive coronary artery bypass benefits postoperative lung function in patients with known respiratory problems" [7]. Similarly, Guizilini et al through a comparative study on 2 groups of patients (CMS, n=10, LMS, n=8) concluded that patients submitted to CABG by LMS had a better preservation and recovery of pulmonary function than those submitted to CMS [8]. Likewise, LMS in the present study resulted in a better postoperative pulmonary function. In contrast, Bauer et al found that a less-invasive approach for CABG with a partial inferior sternotomy did not improve early postoperative pulmonary function when compared with a full sternotomy [9].

In this study we found that mini-sternotomy met most of the advantages of standard sternotomy. It provided a sufficient exposure for safe harvesting of LIMA, aortic cannulation and cross-clamping beside the performance of off-pump anastomosis of LIMA to LAD. Detter et al believe that coronary bypass surgery without the use of CPB is feasible and safe, and offers good early results [10]. Sebastian et al demonstrated the safety and efficacy of mini-sternotomy for the correction of a range of congenital cardiac diseases with improved cosmetic results [11]. Although LMS was used in this study for single vessel revascularization, many authors have shown that it can be used for multiple vessels bypass [5] [6] [12].

One appealing feature of LMS is the ease of conversion to full sternotomy if needed

<sup>[12][13]</sup>. In this study, a single case (5%) was converted into CMS while it was not necessary in the study of Del et al [5] but required in 2/79 patients (2.5%) in Xiao et al series <sup>[6]</sup>. Moreover, LMS is reported to be safe and associated with fewer transfusions and infections <sup>[14]</sup>.

### CONCLUSION

Despite the small number of patients enrolled in this study, it did show some advantages of mini-sternotomy as compared to full sternotomy. Mini-sternotomy was found to be safe for single coronary bypass in selected high-risk patients. Better pulmonary function, less pain, early return to work and better cosmetic results are few to mention.

### Conflict of Interest

None to be declared.

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