

# Partial Upper Sternotomy for Concomitant with Ascendant Aorta Replacement or Isolated Aortic Valve Implantation



Tamir Özer<sup>1</sup>, Mustafa Akbulut<sup>2</sup>, Ahmet Çağrı Aykan<sup>3</sup>, İlker Mataracı<sup>1</sup>, Eray Aksoy<sup>4</sup>, Mehmet Altuğ Tuncer<sup>2</sup>

<sup>1</sup> Ahi Evren Chest Cardiovascular Surgery Education and Research Hospital, Clinic of Cardiovascular Surgery, Trabzon, Turkey.

<sup>2</sup> Kartal Koşuyolu High Specialization Training and Research Hospital, Clinic of Cardiovascular Surgery, İstanbul, Turkey

<sup>3</sup> Ahi Evren Chest Cardiovascular Surgery Education and Research Hospital, Clinic of Cardiology, Trabzon, Turkey

<sup>4</sup> Amerikan Hospital, Clinic of Cardiovascular Surgery, İstanbul, Turkey.

## ABSTRACT

**Introduction:** Less-invasive procedures have gained more widespread adoption among cardiovascular surgeons as a result of continuous advances in the field of cardiac surgical techniques. It has now become clear that even smaller incisions may provide adequate exposure in certain cardiac surgical procedures without compromising the surgeon's view of the surgical field. Furthermore, a limited incision offers the advantage of cosmetic outcomes, hence an improved quality-of-life after the operation. Herein, we report our experience regarding the use of partial upper sternotomy with limited skin incision for isolated or combined aortic valve operations.

**Patients and Methods:** A total of 34 patients underwent aortic valve surgery via partial J-shaped upper sternotomy in two separate centers between January 2013 and December 2014. Sixteen patients (47%) underwent an isolated aortic valve replacement, while 18 patients (53%) underwent a modified Bentall procedure. Descriptive data included demographic and clinical outcome parameters.

**Results:** Mean age was  $54 \pm 14$  years (range: 19 to 82 years) and there were 11 females (32%). The average duration of surgery was  $6.8 \pm 1.8$  hours, ranging from 4 to 10 hours. Early mortality occurred in 1 patient. Two patients had wound infection and they were re-hospitalized for wound care.

**Conclusion:** Our preliminary result regarding the use of partial upper ministernotomy is encouraging. The technique allows adequate exposure during aortic valve surgery, even in procedures involving the proximal ascending aorta. Further studies are warranted to test the safety and efficacy of this approach.

**Key Words:** Minimally invasive aortic valve surgery; ministernotomy; minimally invasive cardiac surgery; aortic valve replacement

## Asendan Aort Replasmanı ile Birlikte veya İzole Aort Kapak İmplantasyonu İçin Parsiyel Üst Sternotomi

### ÖZET

**Giriş:** Kalp cerrahisi tekniklerindeki ilerlemelerle birlikte, minimal invaziv yaklaşımlar cerrahlar tarafından gittikçe daha çok tercih edilmektedir. Daha küçük bir insizyon yapılması belirli cerrahi prosedürler sırasında cerrahın hareketlerine engel olmadan yeterli görünürlük sağlayabilmektedir. Dahası sınırlı bir insizyon daha iyi kozmetik sonuçlar ve daha iyi yaşam kalitesi sunmaktadır. Bu çalışma izole ve kombine aort kapak operasyonları için sınırlı cilt insizyonu ile parsiyel üst sternotomi kullanımına dair deneyimlerimizi sunmaktadır.

**Hastalar ve Yöntem:** Ocak 2013-Aralık 2014 tarihleri arasında toplam 34 hastaya parsiyel J-şeklinde üst sternotomi yoluyla aort kapak cerrahisi uygulandı. On altı hastada (%47.0) izole aort kapak replasmanı, 18 hastada (%53) modifiye Bentall prosedürü gerçekleştirildi. Tanımlayıcı veriler olarak demografik ve klinik sonuç parametreleri bildirildi.

**Bulgular:** Ortalama yaş  $54 \pm 14$  yıldır (aralık 19 ila 82 yaş) ve hastaların 11 (%32)'i kadındır. Ortalama ameliyat süresi  $6.8 \pm 1.8$  saattir (aralık 4 ila 10 saat). Erken mortalite bir hastada meydana geldi. İki hasta yara yeri enfeksiyonu nedeniyle yara bakımı için rehospitalize edildi.

**Sonuç:** Aort kapak cerrahisi için parsiyel üst ministernotomi kullanımına dair ilk sonuçlarımız cesaret vericidir. Söz konusu teknik aort kapak cerrahisi sırasında, proksimal asendan aorta dahil yeterli ulaşılabilirlik sağlamaktadır. Tekniğin güvenilirliğinin ve etkililiğinin sınanması için daha ileri düzeyde çalışmalara ihtiyaç vardır.

**Anahtar Kelimeler:** Minimal invaziv aort kapak cerrahisi; ministernotomi; minimal invaziv kalp cerrahisi; aort kapak replasmanı

## Correspondence

Tamir Özer

E-mail: drtanilozer@gmail.com

Submitted: 04.07.2015

Accepted: 15.07.2015

@ Copyright 2015 by Koşuyolu Heart Journal.  
Available on-line at  
www.kosuyoluheartjournal.com

## INTRODUCTION

Classical median sternotomy continues to be the method of choice in most cardiac surgical procedures, allowing adequate visualization of the heart and major mediastinal vessels, and thus increasing the surgeons' confidence during the operation. However, as a result of the continuous advances in the field of cardiac surgery, less-invasive approaches are gaining a more widespread popularity among surgeons. It is doubtless to say that usage of minimally invasive techniques in cardiac surgery would improve the post-surgical quality of life in patients<sup>(1,2)</sup>. This study reports our experience regarding the use of partial upper sternotomy with limited skin incision in isolated or combined aortic valve surgery.

## PATIENTS and METHODS

The study protocol was approved by local institutional boards of the two participating centers. This was a retrospective study involving patients who underwent aortic valve replacement in two separate centers, either with ascending aortic replacement or alone, between January 2013 and December 2014. Search of the two hospitals' databases revealed a total of 34 patients who underwent isolated aortic valve replacement or Bentall procedure during the aforementioned time period. Minimal invasive cardiac operations including mitral or aortic valve surgery, coronary artery bypass grafting (CABG) and atrial septal defect repair have been being performed occasionally in both institutions since 2010 and the results of these procedures have been previously reported elsewhere<sup>(3-5)</sup>. The present study included only patients undergoing aortic valve replacement and those undergoing other procedures were excluded. Patients were also excluded if conversion to standard approach occurred at any stage of the operation. The decision to perform minimal invasive partial upper sternotomy during aortic valve surgery was at the discretion of the surgeons, and this decision was primarily based on patients' expectations rather than certain criteria. Baseline characteristics of patients are shown in Table 1.

### Surgical Technique

All operations were performed under general anesthesia. Beginning from the suprasternal notch, a 6 to 12 cm long midline skin incision was made. Sternum was divided down to

the fourth intercostal space and angled right with an oscillating saw (J shape). A Finochietto sternal retractor was used to separate the sternal edges. The remnant thymus gland and/or fatty tissues were excised to improve visualization. The pericardium was opened just over the aortic root and pericardial edges were suspended to achieve exposure of the ascending aorta and the left ventricular outflow tract. The arterial cannulation was made on the distal ascending aorta. The venous cannulation was performed either through right atrial appendix or percutaneously through the right femoral vein. In cases where overfilling of the heart ensued, the heart was decompressed through vacuum assisted venous drainage via a right femoral vein cannula. Cross-clamping (Cosgrove clamp) the aorta and infusion of cardioplegia solution were performed using the standard techniques (aortic root needle or directly through coronary ostium). In patients who underwent isolated aortic valve replacement, aortic valve leaflets were resected and calcifications were scrapped, as necessary. A suitable sized mechanical or bioprosthesis aortic valve was implanted into the aortic annulus using interrupted sutures. In patients who underwent a modified Bentall procedure, the procedure was carried out as first described by Yakut, where appropriate sized aortic valve prosthesis was sewed into an appropriate sized tubular Dacron graft and this composite graft was implanted into the aortic root in a similar fashion used in isolated aortic valve replacement<sup>(6)</sup>. A 36 Fr drainage tube was placed into the mediastinal cavity as to lie beneath the sternum.

### Statistical Analysis

No statistical analyses were performed. Descriptive data included demographic and clinical outcome parameters.

## RESULTS

The average duration of surgery was  $6.8 \pm 1.8$  hours (range: 4-10 hours) (time elapsed from induction of anesthesia to wound closure with sterile sponges). Mean cardiopulmonary bypass (CPB) time was  $98.5 \pm 37.7$  (range 57.0 to 240.0 min). Mean cross-clamp time was  $53.5 \pm 25.4$  (range 26.0 - 136.0 min). Operative and postoperative data are depicted in Table 2. Early mortality (within postoperative 30 days) occurred in one patient who underwent a reoperation. This was an 82-year-old patient who had comorbid chronic pulmonary disease. The patient could not be weaned from ventilatory support and died due to respiratory failure at postoperative day 4. Two patients were re-admitted to hospital due to wound complications and fully recovered with appropriate antibiotics and wound care.

## DISCUSSION

Maximum possible control over the field of surgery is a prerequisite in all branches of surgery. In conventional cardiac surgery, this can mostly be achieved by full sternotomy<sup>(7)</sup>. On the other hand, with the advances in the field of cardiac surgery, now it is possible to achieve good surgical exposure levels with minimally invasive techniques, similar to those achieved with conventional approaches. For instance, many

**Table 1. Preoperative characteristics of patients**

|                                     |                                 |
|-------------------------------------|---------------------------------|
| Mean age                            | 54 ± 14 (range 19-82)           |
| Gender                              | 11 Female (32%) / 23 Male (68%) |
| Mean body mass index                | 25.6 (range 19.3 - 43.3)        |
| Diabetes mellitus                   | 2 (6%)                          |
| Chronic renal failure               | 2 (6%)                          |
| Chronic lung disease                | 4 (12%)                         |
| Previous full sternotomy            | 1 (3%)                          |
| Type of cardiac intervention        |                                 |
| Isolated aortic valve surgery       | AS: 16 (47%) AR: 0 (0%)         |
| Concomitant ascending aorta surgery | AS: 2 (6%) AR: 16 (47%)         |

AS: Aortic stenosis, AR: Aortic regurgitation

authors have found no significant differences between full sternotomy and mini-sternotomy applications, and in aortic valve surgery, upper mini-sternotomy has been associated with adequate surgical exposure of the heart and great vessels<sup>(8)</sup>. Moreover, there are no requirements for performing minimally invasive surgery in terms of patient characteristics<sup>(9)</sup>.

As a matter of fact, limiting the area of incisions cannot not be aimed at the expense of increased frequency of adverse consequences in comparison with the conventional methods. In this regard, most of the reports on the use of mini-sternotomy suggest that this approach may not only allow achieving similar surgical outcomes, but may even provide certain advantages over the conventional strategy, i.e. full sternotomy, such as a shorter duration of ventilator support, ICU or hospital stay, as well as reduced blood loss<sup>(8-10)</sup>.

In a study by Tabata et al. where conversion to full sternotomy was examined, the conversion to full sternotomies in upper ministernotomies were usually required urgently after cross clamp removal and were associated with serious morbidity and mortality<sup>(11)</sup>. However, fortunately this occurrence was uncommon. During our study period (2013, 2014), conversion to standard approach was required only in a single occasion in which a decision to conversion was made soon after ministernotomy due to unusually low placed aorta precluding access through upper ministernotomy. The procedure was completed using the conventional method without any complications.

Aortic valve surgery through upper ministernotomy in patients who had undergone a previous full sternotomy was shown to be safe<sup>(12,13)</sup>. In our series, there was only a single patient requiring re-do surgery. This patient who was scheduled for isolated AVR had a previous history of CABG and his internal mammary artery graft was patent. Although surgery could be performed without requirement to conversion to full sternotomy, the patient could not be weaned from ventilator and died at postoperative day 4.

**Table 2. Operative and postoperative data of patients**

|                                |                                 |
|--------------------------------|---------------------------------|
| Type of operation              |                                 |
| Isolated AVR                   | 16 (47%)                        |
| Modified Benthall procedure    | 18 (53%)                        |
| Duration of operation (hours)  | 6.8 ± 1.8 (range, 4-10 h)       |
| CPB time (hours)               | 98.5 ± 37.7 (range, 57-240 min) |
| CC time (hours)                | 53.5 ± 25.4 (range, 26-136 min) |
| Duration of intubation (hours) | 7.3 ± 2.1 (range, 5-19 min)     |
| Drainage (mL)                  | 247 ± 115 (50-500 mL)           |
| ICU stay (days)                | 1.5 ± 0.5 (1-2 days)            |
| Hospital stay (days)           | 7.1 ± 1.3 (5-11 days)           |
| Early mortality                | 1 (2.9%)                        |
| Morbidity                      | 2 (5.8%)                        |

AVR: Aortic valve replacement, CC: Cross clamp, CPB: Cardiopulmonary bypass, ICU: Intensive care unit

Majority of the previously reported studies involved a larger sample size than this study. In the study by Soppa et al., there were no significant differences between procedures who were carried out by experts and trainees<sup>(14)</sup>. Thus, such observations suggest that cardiac surgery specialists who are competent for aortic valve surgery may consider performing mini sternotomy without being discouraged by a presumed limitation for aortic valve surgery cases.

In conclusion, we believe that upper partial sternotomy represents a good alternative to the conventional approaches for the majority of patients undergoing aortic valve surgery, with no limitation of the surgical exposure.

#### CONFLICT of INTEREST

The authors reported no conflict of interest related to this article.

#### FINANCIAL SUPPORT

The authors did not receive any financial support for the research process or for writing the manuscript.

#### AUTHORSHIP CONTRIBUTIONS

*Concept/Design:* TÖ, AA, EA, İM, MT

*Analysis/Interpretation:* TÖ, AÇA, EA

*Data acquisition:* TÖ, MA

*Writing:* TÖ, EA

*Critical revision:* MA, AA, İM, MT

*Final approval:* All of authors

#### REFERENCES

- Liu J, Sidiropoulos A, Konertz W. Minimally invasive aortic valve replacement (AVR) compared to standard AVR. *Eur J Cardiothorac Surg* 199;16 (Suppl 2):S80-S3.
- Gilmanov D, Bevilacqua S, Murzi M, Cerillo AG, Gasbarri T, Kallushi E, et al. Minimally invasive and conventional aortic valve replacement: propensity score analysis. *Ann Thorac Surg* 2013;96:837-43.
- Özer T, Yücel M, Mataracı İ, Hanedan MO, Sayar U, Emir İ. Minimally invasive cardiac surgery experiences in a district branch hospital. *Koşuyolu Heart Journal* 2014;17:110-3.
- Özer T, Hanedan MO, Sayar U, Demirbaş M, Emir İ, Yücel M, et al. Our minimally invasive cardiac surgery experiences. *Turkish J Thorac Cardiovasc Surg* 2014; (Suppl 1):456.
- Arslan Ö, Akbulut M, Erden B, Ak A, Taş S, Çayhan B, et al. Minimally invasive surgical treatment of aortic pathologies (Mini-J-Sternotomy and innominate vein cannulation). *Turkish J Thorac Cardiovasc Surg* 2014;(Suppl 1):45.
- Yakut C. The Flanged Technique: A new modified procedure for reconstructed continuity of aortic valve and ascending aorta. *Koşuyolu Heart J* 1999;3:72-5.
- Khonsari S, Sintek CF. *Cardiac Surgery: Safeguards and pitfalls in operative technique*. 4<sup>th</sup> ed. Philadelphia: Lippincott Williams & Wilkins, Wolters Kluwer Health, 2008.
- Brown ML, McKellar SH, Sundt TM, Schaff HV. Ministernotomy versus conventional sternotomy for aortic valve replacement: a systematic review and meta-analysis. *J Thorac Cardiovasc Surg* 2009;137:670-9.

9. Tabata M, Umakanthan R, Cohn LH, Bolman RM III, Shekar PS, Chen FY, et al. Early and late outcomes of 1000 minimally invasive aortic valve operations. *Eur J Cardiothorac Surg*. 2008;33:537-41.
10. Ceresa F, Sansone F, Patanè F. Aortic valve replacement through the upper minister-notomy: preliminary experience with modified technique. *G Chir* 2012;33:311-3.
11. Tabata M, Umakanthan R, Khalpey Z, Aranki SF, Couper GS, Cohn LH, et al. Conversion to full sternotomy during minimal access cardiac surgery: reasons and results during a 9.5-year experience. *J Thorac Cardiovasc Surg* 2007;134:165-9.
12. Byrne JG, Karavas AN, Adams DH, Aklog L, Aranki SF, Couper GS, et al. Partial upper re-sternotomy for aortic valve replacement or re-replacement after previous cardiac surgery. *Eur J Cardiothorac Surg* 2000;18:282-6.
13. Dell'Amore A, Del Giglio M, Calvi S, Pagliaro M, Fedeli C, Magnano D, et al. Mini resternotomy for aortic valve replacement in patients with patent coronary bypass grafts. *Interact CardiovascThorac Surg* 2009;9:94-7.
14. Soppa G, Yates M, Viviano A, Smelt J, Valencia O, van Besouw JP, et al. Trainees can learn minimally invasive aortic valve replacement without compromising safety. *Interact Cardio Vasc Thorac Surg* 2015;20:458-62. doi:10.1093/icvts/ivv428.