Right Mini-Thoracotomy in the Surgical Treatment of Structural Heart Diseases (SHDs): An Institutional Experience

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ABSTRACT

Introduction: Surgical treatment of structural heart diseases continues to predominantly involve median sternotomy, despite the ongoing trends favoring minimally invasive approaches that have persisted for many years. In this study, we present data on structural heart disease (SHD) surgeries conducted by our institute using a right mini-thoracotomy approach.

Patients and Methods: This single-center retrospective study included 58 patients who underwent right mini-thoracotomy procedures between February 2018 and June 1, 2023. Preoperative demographic and medical data were collected from patient files and records. Perioperative and 30-day outcome data were obtained through the national electronic record system.

Results: The average age of the participants was 39.9. Female patients accounted for 31.6% (n= 18) of the participants. The majority of surgeries in this study involved peripheral cannulation and conventional cardioplegia. Mitral valve repair and atrial septal defect closure were the most common procedures performed. Intraoperative outcomes showed favorable results, with no instances of significant bleeding, structural complications, or mortality. Regarding the postoperative 30-day outcomes, the stroke rate was 1.8% (n= 1) among the patients. There were no reported cases of transient ischemic attack (TIA), myocardial infarction (MI), and mortality. The conversion to median sternotomy occurred in 3.4% (n= 2) of the cases. Reoperation and re-exploration were required in 1.8% (n= 1) of the cases. The mean length of stay in the ICU was 1.7 days, while the mean length of ward stay was 4.2 days.

Conclusion: This study contributes to the evidence supporting the shift towards minimally invasive approaches in the surgical management of structural heart disease. The low rate of intraoperative conversion, absence of major complications, and favorable postoperative outcomes highlight the safety and feasibility of right mini-thoracotomy. Continued advancements in surgical techniques and clinical expertise are expected to further optimize patient outcomes and improve the quality of care in this field.

Key Words: Thoracotomy; MICS; MVR; mitral repair

Yapısal Kalp Hastalıklarının (YKH) Cerrahi Tedavisinde Sağ Mini-Torakotomi: Enstitü Tecrübesi

ÖZET

Giriş: Yapısal kalp hastalıklarının cerrahi tedavisi, yıllardır süregelen minimal invaziv eğilimlere rağmen halen daha çok median sternotomi ile yapılmaktadır. Bu çalışmada, enstitümüz tarafından sağ mini torakotomi ile gerçekleştirilen kalp ameliyatlarını sunuyoruz.

Hastalar ve Yöntem: Bu tek merkezli retrospektif çalışmaya, Şubat 2018 ile 1 Haziran 2023 tarihleri arasında sağ mini torakotomi uygulanan 58 hasta dahil edildi. Ameliyat öncesi demografik ve tıbbi veriler, hasta dosyaları ve sistem kayıtlarından toplandı. Perioperatif ve 30 günlük sonuç verileri ulusal elektronik kayıt sisteminden elde edildi.

Bulgular: Katılımcıların yaş ortalaması 39.9'du. Katılımcıların %31.6'sını (n= 18) kadın hastalar oluşturmaktaydı. Ameliyatların çoğunda periferik kanülasyon ve konvansiyonel kardiyopleji kullanıldı. Mitral kapak tamiri ve atriyal septal defektin onarımı en sık uygulanan prosedürlerdi. İntraoperatif sonuçlar, önemli kanama, yapısal komplikasyon veya ölüm vakası olmadan olumlu sonuçlar gösterdi. Postoperatif 30 günlük sonuçlara bakıldığında, hastalarda inme oranı %1.8 (n= 1) idi. Geçici iskemik atak (GİA), miyokard enfarktüsü (MI) ve ölüm vakası bildirilmedi. Vakaların %3.4'ünde (n= 2) medyan sternotomiye geçiş olduğu görüldü. Olguların %1.8'inde (n= 1) tekrar operasyon ve tekrar eksplorasyon uygulandı. Yoğun bakımda ortalama kalış süresi 1.7 gün, serviste ortalama kalış süresi ise 4.2 gündü.

Sonuç: Bu çalışma, yapısal kalp hastalığının cerrahi tedavisinde minimal invaziv yaklaşımlara geçişi destekleyen kanıtlara katkıda bulunmaktadır. Düşük intraoperatif dönüşüm oranı, majör komplikasyonların olmama-

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sı ve olumlu postoperatif sonuçlar, sağ mini torakotominin güvenliğini ve fizibilitesini vurgulamaktadır. Cerrahi teknikler ve klinik uzmanlıkta devam eden ilerlemelerin hasta sonuçlarını daha da optimize etmesi ve bu alandaki bakım kalitesini iyileştirmesi beklenmektedir.

Anahtar Kelimeler: Torakotomi; MICS; MVR; mitral onarım

INTRODUCTION

Open heart surgery initially relied predominantly on sternotomy in the early 20th century, during its experimental stages, and later during the latter part of the 20th century and the 21st century when it became widely adopted and standardized[1]. However, thoracotomy has resurfaced as a prominent approach in the past two decades and has gained widespread acceptance[1]. Particularly, mini-thoracotomy has gained popularity, initially in the repair of septal defects, and subsequently in interventions involving the mitral and tricuspid valves[2-4]. In contrast to median sternotomy, mini-thoracotomy offers advantages such as accelerated recovery and shorter hospitalization periods due to the avoidance of bone tissue incision, which facilitates quicker physical recuperation[2-6]. Additionally, mini-thoracotomy minimizes the surgical area, resulting in reduced bleeding and a decreased need for blood transfusions, thereby lowering perioperative morbidity and shortening hospital stays[2-6]. However, the diminished surgical field in mini-thoracotomy poses challenges to surgical exposure and visibility, especially in complex heart surgeries involving multiple valve repairs and procedures, casting doubt on the technical success of such operations[7,8].

The present study aims to present the perioperative and postoperative 30-day outcomes of patients with structural heart conditions who underwent right mini-thoracotomy between 2018 and 2023 at our institution, where over 2000 heart surgeries per year were performed using median sternotomy.

PATIENTS and METHODS

Study Design

This single-center retrospective study aimed to assess the feasibility and outcomes of right mini-thoracotomy heart surgery in patients with structural heart diseases. A total of 58 patients who underwent this surgical technique between February 2018 and June 1, 2023, were included in the evaluation.

Procedure

CT scan was performed on all patients in order to make preoperative anatomical evaluation and to detect possible adhesions. A 5 to 10 cm long thoracotomy was performed at the right Submammarian area through the 3rd, 4th, or 5th intercostal space according to the procedure (Figure 2). For aortic interventions, it could be also performed at the second intercostal space. A soft tissue retractor or mini-thoracotomy retractor was used to expose the surgical area. (Figure 3). The incisions were extended if adequate exploration was not obtained. Mostly direct right femoral arterial and venous cannulation was performed after ultrasonographic evaluation in addition to jugular venous cannulation with the Seldinger technique under Transesophageal Echocardiography (TEE)

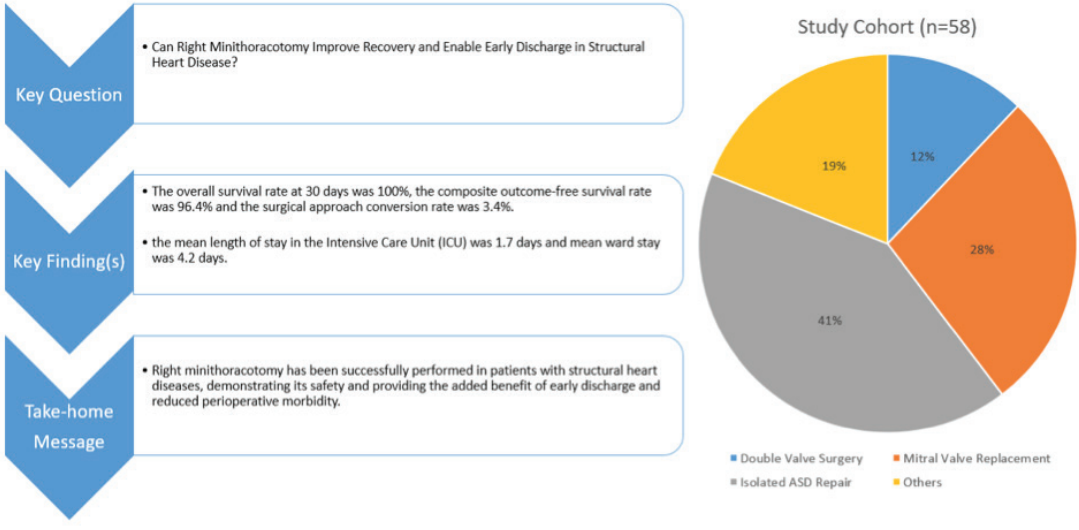

Figure 1. Central figure.

Figure 2. Right minithoracotomy incision.

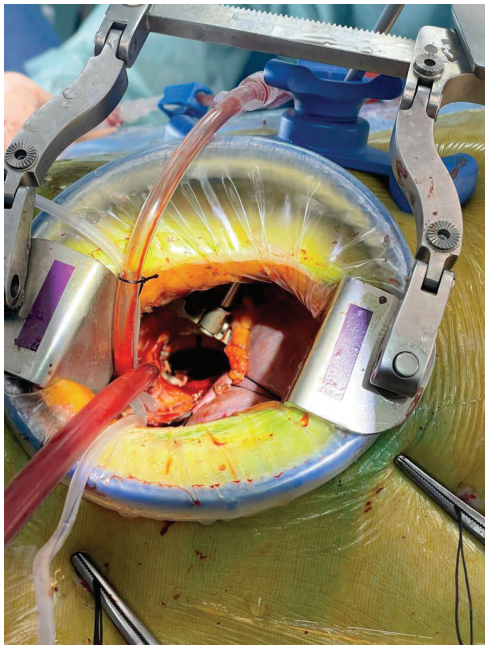

Figure 3. Operative view of mini thoracotomy during mitral valve intervention.

guidance. The pericardium was opened from the diaphragm to the aorta by securing the phrenic nerve. Direct aortic arterial and bi-caval venous cannulation were also performed for suitable patients. A cardioplegia cannula was inserted directly into the aorta. Antegrade cold blood cardioplegia was most commonly utilized. Del Nido and Custadiol solutions were also used for complex cases. The aorta was clamped with a Chit-wood clamp through a 1 cm skin incision which then would be used for chest tube insertion.

Patients and Data

The preoperative demographic and medical information of patients who underwent surgery between 2018 and 2023 were meticulously gathered from patient files and records. This task was performed by a cardiac surgery resident, closely supervised by an academic cardiac surgeon, following the approval of the ethics committee. The collection of perioperative and 30-day outcome data was facilitated through the national electronic record system, with the active involvement of both the cardiac surgery resident and the academic heart surgeon.

Statistical Analysis

In our report, for non-continuous variables, we presented percentages and counts, while for continuous variables, we reported mean values and standard deviations (SDs).

RESULTS

Patient Characteristics

Table 1 presents the preoperative demographics and medical background of 58 individuals who underwent thoracotomy. The average age of the participants was 39.9 years, with a standard deviation of 16.1. Among the participants, 31.6% (n= 18) were female. The mean body mass index (BMI) was 24.1, with a standard deviation of 5.5. Smoking was reported by 29.6% (n= 16) of the participants. In terms of comorbidities, 5.4% (n= 3) had coronary artery disease (CAD), 21.8% (n= 12) had hypertension (HT), 39.3% (n= 22) had pulmonary hypertension (PHT), 3.6% (n= 2) had peripheral artery disease (PAD), 20% (n= 11) had atrial fibrillation (AFib), 10.9% (n= 6) had chronic obstructive pulmonary disease (COPD), 10.9% (n= 6) had type 2 diabetes mellitus (T2DM), and 3.6% (n= 2) had chronic kidney disease (CKD). The left ventricular ejection fraction (LVEF) was measured to be 62.2% with a standard deviation of 7.4. The mean hemoglobin (HGB) level was 12.5 g/dL with a standard deviation of 2.0, and the mean hematocrit (HCT) was 38.6% with a standard deviation of 5.3.

Surgical Techniques and Approaches

Table 2 presents the surgical techniques and surgeries. Regarding cannulation, peripheral cannulation was the chosen method in the majority of cases, accounting for 83.4% (n= 45) of the participants, while central cannulation was used in 16.6% (n= 9) of the cases. In terms of cardioplegia techniques, the Del Nido approach was employed in 12.3% (n= 7) of the surgeries, conventional cardioplegia in 68.3% (n= 39) of the surgeries, and custadiol cardioplegia in 10.5% (n= 6) of the surgeries. Various types of surgeries were performed on the participants. Mitral valve replacement (MVR) accounted for 27.5% (n= 16) of the cases, while aortic valve replacement (AVR) and myxoma resection were performed in only 1.8% (n= 1) each. Mitral valve repair (MVR) was conducted in 22.4% (n= 13) of the cases, followed by tricuspid valve repair in 15.5% (n= 9). Atrial septal defect (ASD) closure was

Table 1. Preoperative demographics and medical history

	Thoracotomy (n= 58)	
Variable	**Mean ± SD**	**% (n)**
Age	39.9 ± 16.1	
Gender (female)		31.6 (18)
BMI	24.1 ± 5.5	
Smoking		29.6 (16)
CAD		5.4 (3)
HT		21.8 (12)
PHT		39.3 (22)
PAD		3.6 (2)
AFib		20 (11)
COPD		10.9 (6)
T2DM		10.9 (6)
CKD		3.6 (2)
LVEF (%)	62.2 ± 7.4	
HGB (g/dL)	12.5 ± 2.0	
HCT (%)	38.6 ± 5.3	

BMI: Body mass index, CAD: Coronary artery disease, HT: Hypertension, PHT: Pulmonary hypertension, PAD: Peripheral arterial disease, AFib: Atrial fibrillation, COPD: Chronic obstructive pulmonary disease, T2DM: Type 2 diabetes mellitus, CKD: Chronic kidney disease, LVEF: Left ventricular ejection fraction, HGB: Hemoglobin, HCT: Hematocrit.

Table 2. Surgical techniques and surgeries

	Thoracotomy (n= 58)	
Variable	**Mean ± SD**	**% (n)**
Cannulation		
Peripheral		83.4 (45)
Central		16.6 (9)
Cardioplegia		
Del Nido		12.3 (7)
Conventional		68.3 (39)
Custadiol		10.5 (6)
Surgery		
MVR		27.5 (16)
AVR		1.8 (1)
MVr		22.4 (13)
Tricuspid repair		15.5 (9)
ASD Closure		44.8 (26)
Complex surgery (two or more procedures)		22.4 (13)

MVR: Mitral valve replacement, AVR: Aortic valve replacement, MVr: Mitral valve repair, ASD Closure: Atrial septal defect closure.

Table 3. Intraoperative outcomes

	Thoracotomy (n= 58)	
Variable	**Mean ± SD**	**% (n)**
CPB time	138.0 ± 65.8	
AXC time	85.1 ± 54.3	
Transfusion requirement		26.3 (15)
Transfused PRBC (U)	1.1 ± 0.8	
Transfused FFP (U)	1.1 ± 0.8	
Conversion to median sternotomy		3.4 (2)
Massive bleeding		0.0 (0)
Structural complications		0.0 (0)
Mortality		0.0 (0)

CPB time: Cardiopulmonary bypass time, AXC time: Aortic cross-clamp time, Transfused PRBC (U): Transfused packed red blood cells (Units), Transfused FFP (U): Transfused fresh frozen plasma (Units).

performed in 44.8% (n= 26) of the surgeries. In addition, complex surgeries involving two or more procedures were carried out in 22.4% (n= 13) of the cases.

Intraoperative Findings

Table 3 presents the intraoperative outcomes. The mean cardiopulmonary bypass (CPB) time in this study was 138.0 minutes, with a standard deviation of 65.8. The mean aortic cross-clamp (AXC) time was 85.1 minutes, with a standard deviation of 54.3. Transfusion requirements were observed in 26.3% (n= 15) of the cases, with an average of 1.1 units of packed red blood cells (PRBC) and fresh frozen plasma (FFP) transfused. The conversion to median sternotomy was necessary in 3.4% (n= 2) of the cases. Notably, no instances of massive bleeding, structural complications, or mortality were encountered during the procedures.

Postoperative Outcomes

The postoperative outcomes at the 30-day mark are demonstrated in Table 4: 40.0% (n= 22) required transfusion, 3.5% (n= 2) experienced infection, 1.8% (n= 1) had new-onset atrial fibrillation, 15.5% (n= 9) developed acute kidney injury, and 1.8% (n= 1) suffered a stroke. There were no reported cases of TIA, myocardial infarction, and mortality. Re-exploration and reoperation occurred in 1.8% (n= 1) of the cases. The average drainage volume was 377 mL, the mean intubation time was 8.6 hours, and the mean length of stay in the ICU was 1.7 days. The length of ward stay was 4.2 days. At postoperative day one, the mean hemoglobin level was 10.6 g/dL and the mean hematocrit level was 29.4%.

DISCUSSION

In the realm of surgical interventions for structural heart diseases, the conventional approach has long involved highly invasive procedures utilizing a median sternotomy. However, with the advent of transcatheter therapies and the growing emphasis on quality of life-centered medicine, there has been a notable shift towards a minimally invasive paradigm in the surgical management of structural heart disease[7,9]. Recent advancements in valve surgery have highlighted the growing evidence supporting the benefits of mini-thoracotomy[9,10]. A comprehensive meta-analysis, encompassing 109 studies and 38.106 patients, published in 2022, revealed that mini-thoracotomy offers distinct advantages over median sternotomy, including reduced hospitalization durations and decreased blood product utilization[10].

Furthermore, the utilization of right mini-thoracotomy in atrial septal defect (ASD) repair has gained significant traction. This surgical approach, which has a longer history compared to valve surgery, has become relatively more prevalent. In a meta-analysis published in 2021, incorporating data from seven studies and 665 patients, right mini-thoracotomy demonstrated superior recovery parameters compared to median sternotomy[11]. Notably, the analysis identified significantly shorter hospitalization times, reduced intensive care unit stays, and decreased intubation durations associated with the right mini-thoracotomy technique.

In our study, a cohort of 58 patients with structural heart disease underwent open heart surgery, with a notable subset requiring complex cardiac procedures. Among these patients,

Table 4. Postoperative outcomes at 30-day

	Thoracotomy (n= 58)	
Variable	**Mean ± SD**	**% (n)**
Transfusion requirement		40.0 (22)
Infection		3.5 (2)
AKI		15.5 (9)
RRT		0.0 (0)
AFib		1.8 (1)
TIA		0.0 (0)
Stroke		1.8 (1)
MI		0.0 (0)
Surgical Re-exploration		1.8 (1)
Reoperation		1.8 (1)
Mortality		0.0 (0)
Drainage (ml)	377 ± 236	
Intubation Time (h)	8.6 ± 5.5	
Length of ICU stay (D)	1.7 ± 1.2	
Length of Ward stay (D)	4.2 ± 1.6	
Po 1 HGB (g/dL)	10.6 ± 3.2	
Po 1 HCT	29.4 ± 5.4	

AKI: Acute kidney injury, TIA: Transient ischemic attack, MI: Myocardial infarction, Drainage (ml): Drainage volume in milliliters, Intubation Time (h): Duration of intubation in hours, Length of ICU stay (D): Length of stay in the intensive care unit in days, Length of Ward stay (D): Length of stay in the general ward in days, Po 1 HGB (g/dL): Hemoglobin level at postoperative day 1 in grams per deciliter, Po 1 HCT: Hematocrit level at postoperative day 1, RRT: Renal replacement therapy.

because of strict adhesions, the need for intraoperative conversion from median sternotomy was observed in a mere 3.4% (n= 2) of cases[2-6,10]. Encouragingly, these individuals experienced successful postoperative outcomes, with no instances of morbidity or mortality. The observed conversion rate aligns closely with the existing literature, reflecting the effectiveness and feasibility of the surgical approach employed. Furthermore, our findings revealed composite outcomes, such as surgical reoperation and stroke, occurring in one patient each. In addition, one patient had postoperative new atrial fibrillation, which completely resolved on the postoperative sixth day. However, no instances of myocardial infarction (MI), acute kidney injury (AKI), mortality, structural heart defects, significant bleeding necessitating massive transfusion, or the need for renal replacement therapy (RRT) were observed in our patient cohort. These outcomes emphasize the favorable nature of the surgical interventions performed and underscore the successful management of structural heart disease in this context.

At present, our study demonstrates a composite outcome-free survival rate of 96.4% at 30 days, highlighting the overall positive prognosis for patients. Moreover, the overall survival rate of 100% further substantiates the favorable outcomes achieved. Importantly, our study cohort exhibited recovery parameters consistent with previous research, with an average hospital discharge time of less than one week[10,11]. Looking ahead, we anticipate that continued advancements in surgical and clinical expertise will further optimize and expedite the recovery process for patients undergoing open heart surgery for structural heart disease. The promising results obtained in this study underscore the potential for future refinement and improvement in patient outcomes, thereby enhancing the overall quality of care in this field.

CONCLUSION

Our study contributes to the growing body of evidence supporting the shift towards minimally invasive approaches in the surgical management of structural heart disease. By analyzing a cohort of 58 patients who underwent mini-thoracotomy, with a significant proportion requiring complex cardiac procedures, we observed a remarkably low rate of intraoperative conversion from median sternotomy (3.4%).

Importantly, these conversions did not result in any adverse events or mortality, reinforcing the safety and feasibility of the surgical approach employed. Furthermore, our findings highlight the favorable postoperative outcomes achieved in this patient population. We observed low rates of composite outcomes such as surgical reoperation and stroke, and no occurrences of myocardial infarction, acute kidney injury, mortality, structural heart defects, significant bleeding, or the need for renal replacement therapy. These findings emphasize the successful management of structural heart disease through our surgical interventions.

Ethics Committee Approval: This study was approved by the Kartal Koşuyolu High Specialization Training and Research Hospital Ethics Committee (Decision no: 2023/11/702, Date: 04.07.2023).

Informed Consent: This is retrospective study, we could not obtain written informed consent from the participants.

Peer-review: Externally peer-reviewed.

Author Contributions: Concept/Design - MMÖ; Analysis/Interpretation - HİB; Data Collection - MMÖ, AG; Writing - MMÖ; Critical Revision - TÖ, MA; Final Approval - MKK; Overall Responsibility - MMÖ.

Conflict of Interest: The authors have no conflicts of interest to declare.

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