



RESEARCH ARTICLE

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Isolated Tricuspid Valve Surgery: A Single-Center Retrospective Analysis

Mehmet Ali YÜRÜK ^{1,a}
Ahmet Coşkun ÖZDEMİR ^{1,b}

¹ Karadeniz Teknik
University,
Faculty of Medicine,
Department of
Cardiovascular Surgery
Trabzon, TÜRKİYE

^a ORCID: 0000-0002-6066-0655

^b ORCID: 0000-0003-4356-0158

Objective: This study aims to evaluate the early and mid-term clinical and echocardiographic outcomes of patients who underwent isolated tricuspid valve surgery.

Materials and Methods: Patients who underwent isolated tricuspid valve surgery at our center between 2020 and 2024 were retrospectively analyzed. Results of preoperative, postoperative, 1st-month, and 1st-year were shared and compared. Demographic characteristics, operative details, early postoperative complications, and echocardiographic parameters were assessed.

Results: A total of 11 patients were included in the study, with a mean age of 65 (37-75) years and most of the patients were female (63.60%). Ring annuloplasty was performed in 63.60% of the cases, and valve replacement in 36.40%. The hospital mortality rate was 9.10%. Follow-up findings revealed: A significant decrease in pulmonary artery pressure was 42.73 ± 12.52 mmHg to 30.5 ± 9.26 mmHg ($p=0.048$). Also, marked improvement in NYHA functional class was 4 to 1.4 ($p<0.001$). Significant reductions were seen in right atrial and right ventricular diameters ($p<0.001$ and $p=0.035$, respectively).

Conclusion: Isolated tricuspid valve surgery provides successful outcomes with low morbidity and mortality in appropriately selected patients. Postoperative improvements in hemodynamic parameters and symptomatic status were observed. Therefore, timely surgical intervention should be considered in symptomatic patients.

Key Words: Tricuspid regurgitation, isolated tricuspid surgery, right heart, annuloplasty, mortality

İzole Triküspit Kapak Cerrahisi: Tek Merkezli Retrospektif Bir Analiz

Amaç: Bu çalışmanın amacı, izole triküspit kapak cerrahisi uygulanan hastaların erken ve orta dönem klinik ile ekokardiyografik sonuçlarını değerlendirmektir.

Gereç ve Yöntem: Merkezimizde 2020-2024 yılları arasında izole triküspit kapak cerrahisi uygulanan hastalar retrospektif olarak analiz edildi. Preoperatif, postoperatif, 1. ay ve 1. yıl verileri karşılaştırmalı olarak sunuldu. Demografik özellikler, operasyon detayları, erken postoperatif komplikasyonlar ve ekokardiyografik parametreler değerlendirildi.

Bulgular: Çalışmaya toplam 11 hasta dahil edildi. Hastaların yaş ortalaması 65 (37-75) yıl olup, çoğunluğu kadındı (%63.60). Hastaların %63.60'sına halka anuloplasti, %36.40'üne kapak replasmanı uygulandı. Hastane mortalite oranı %9.10 olarak saptandı. Takip bulgularında; pulmoner arter basıncında anlamlı azalma gözlemlendi (42.73 ± 12.52 mmHg'den 30.5 ± 9.26 mmHg'ye; $p=0.048$). Ayrıca NYHA fonksiyonel sınıfında belirgin iyileşme sağlandı (sınıf 4'ten 1.4'e; $p<0.001$). Sağ atriyum ve sağ ventrikül çaplarında da anlamlı düşüşler gözlemlendi (sırasıyla $p<0.001$ ve $p=0.035$).

Sonuç: Uygun şekilde seçilmiş hastalarda izole triküspit kapak cerrahisi, düşük morbidite ve mortalite ile başarılı sonuçlar sunmaktadır. Operasyon sonrası hemodinamik parametrelerde ve semptomatik durumda belirgin iyileşmeler gözlemlenmiştir. Bu nedenle semptomatik hastalarda zamanında cerrahi müdahale düşünülmelidir.

Anahtar Kelimeler: Triküspit yetmezlik, izole triküspit cerrahisi, sağ kalp, anuloplasti, mortalite

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Correspondence

Mehmet Ali YÜRÜK

Karadeniz Teknik
University,
Faculty of Medicine,
Department of
Cardiovascular Surgery
Trabzon - TÜRKİYE

dryuruk@gmail.com

Introduction

Tricuspid valve surgery has long been overlooked, based on the assumption that tricuspid regurgitation (TR) would improve following left-sided valve surgery (1). Although current guidelines recommend surgical intervention for severe TR, the high in-hospital mortality rates associated with tricuspid valve surgery have limited its clinical adoption (2). TR is often addressed during concomitant left-sided valve disease surgery, while isolated tricuspid valve surgery is rarely performed (3).

When severe TR is left untreated, it may lead to right heart failure and subsequent hepatic dysfunction, resulting in significant morbidity and mortality (4). Indeed, a recent meta-analysis demonstrated that TR more than doubles cardiac mortality, independent of pulmonary artery pressure (PAP), left ventricular ejection fraction (LV EF), or right ventricular dysfunction (5).

Surgical intervention is typically pursued in concomitant valve disease, leading to limited knowledge and clinical experience regarding isolated TR surgery. In this study, we aimed to evaluate the early and mid-term outcomes of patients who underwent

isolated tricuspid valve surgery. We hope to contribute to the currently limited literature on this subject by doing so.

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Materials and Methods

Research and Publication Ethics: Ethical approval for this study was granted by the Faculty of Medicine Scientific Research Ethics Committee under decision number 2025/108.

Patients who underwent isolated tricuspid valve surgery at our clinic between 2020 and 2024 were retrospectively analyzed. Data was obtained from patient medical records and the hospital information management system. Patients aged between 18 and 80 years who underwent only isolated tricuspid valve surgery were included, and patients who underwent additional cardiac procedures were excluded.

Patient Follow-up: Preoperative demographic data, intraoperative cardiopulmonary bypass (CPB) details, type of valves or ring used, type of repair, duration of intensive care unit and hospital stay, amount of drainage, transfusion requirements, and echocardiographic findings at the 1st postoperative month and at 1 year were recorded.

Surgical Technique: The surgical approach was determined according to patient-specific characteristics. Patients with a history of previous sternotomy and without peripheral arterial disease were operated on via right lateral thoracotomy. In contrast, those unsuitable for peripheral cannulation or with pleural adhesions detected on thoracic computed tomography underwent median sternotomy. All procedures were performed under cardiopulmonary bypass, either on a beating normothermic heart (n=4) or under cardioplegic arrest (n=7).

Statistical Analysis: The normality of data distribution was assessed using the Shapiro-Wilk test. Repeated measures analysis of variance (RM-ANOVA) was used for normally distributed repeated measurements across time points. The assumption of sphericity for the repeated measures was tested using Mauchly's Sphericity Test. When the sphericity assumption was violated, the degrees of freedom were adjusted using the Greenhouse-Geisser correction ($\epsilon < 0.75$) or the Huynh-Feldt correction ($\epsilon > 0.75$), and the test results were interpreted accordingly. When significant main effects or interactions were detected, Bonferroni-corrected pairwise post hoc comparisons were performed.

Quantitative data were presented as mean $\pm$ standard deviation (Mean $\pm$ SD), median, minimum, and maximum (Median [Min–Max]), and categorical data

were expressed as frequency (n) and percentage (%). A p-value of <0.05 was considered statistically significant in all analyses. Statistical analyses were performed using IBM SPSS version 26.

Results

A total of 11 patients were included in the study. The mean age was 65 (37-75) years, and 63.60% (n=7) were female. The mean left ventricular ejection fraction (LV EF) was preserved at 60 (40-65)%. A history of previous cardiac surgery was present in 3 patients (27.30%). Other demographic characteristics are presented in Table 1.

In terms of surgical technique, 45.40% (n=5) of patients underwent median sternotomy, while 54.60% (n=6) underwent right thoracotomy. Regarding the valve procedure, ring annuloplasty was performed in 63.60% (n=7) and valve replacement in 36.40% (n=4) of the patients. A mechanical valve was used in all patients who underwent replacement.

Table 1. Preoperative demographic and clinical data of the patients

Variables	Median (min-max)
Age (years)	65 (37-75)
Gender M/F (%)	63.60
BSA (m ²)	1.82 (1.51-1.99)
COPD, n (%)	5 (45.50)
Smoking, n (%)	7 (63.60)
Hypertension, n (%)	8 (72.70)
Diabetes Mellitus, n (%)	3 (27.30)
Coronary Artery Disease, n (%)	2 (18.20)
Chronic Renal Failure, n (%)	1 (9.10)
Peripheral Arterial Disease, n (%)	5 (45.50)
EuroSCORE II (points)	4.8 (2.1-37.1)
Previous Cardiac Surgery, n (%)	3 (27.30)
Mitral Valve Replacement (MVR)	2 (18.20)
Coronary Artery Bypass Grafting	1 (9.10)
NYHA (points)	4 (3-4)
Left Ventricular Ejection Fraction (LVEF, %)	60 (40-65)
Atrial Fibrillation, n (%)	3 (27.30)

Min: Minimum, Max: Maximum, COPD: Chronic Obstructive Pulmonary Disease, BSA: Body Surface Area, NYHA: New York Heart Association n = 11

Table 2. Operative parameters, early postoperative data, and complications

Variables	Median (min-max)
CPB Time (minutes)	79 (59-103)
Intubation Time (hours)	6 (4-12)
ICU Stay Duration (hours)	42 (29-268)
Hospital Stay Duration (days)	9 (8-17)
Drainage (mL)	450 (250-750)
Revision, n (%)	1 (%9.10)
Erythrocyte Suspension	3 (2-7)
In-hospital Mortality n (%)	1 (%9.10)
Repair/Replacement, n (%)	7/4 (%63.60)

Min.: Minimum, Maks.: Maximum, CPB: Cardiopulmonary Bypass, ICU: Intensive Care Unit, $n = 11$

The mean intensive care unit stay was 42 (29-268) hours, and the mean hospital length of stay was 9 (8-17) days. The mean drainage volume in the first 24 hours was 450 (250-750) mL. Revision surgery was required in only one patient (9.10%). One in-hospital mortality was observed and one patient died due to postoperative cerebrovascular accident (Table 2).

Although a slight decrease in postoperative LV EF was observed at the 1-month follow-up, values at 1 year

were similar to preoperative levels (55.91±7.69 vs. 52.86±8.88 vs. 53.51±7.09, respectively). PAP significantly decreased [from 42.73±12.52 mmHg to 30.5±9.26 mmHg ($p=0.048$)]. Symptomatic improvement in NYHA functional class was observed from the first month, reaching an average of class 1.4 at the 1-year follow-up ($p<0.001$). Significant reductions were also observed in the diameters of the right atrium (RA) (54.45±10.98 mm to 48.5±9.66 mm, $p<0.001$) and right ventricle (RV) (43.27±7.7 mm to 37.8±4.59 mm, $p=0.035$) (Table 3 – Figure 1).

Table 3. Comparison of echocardiographic findings and NYHA classification over time

Variables	Pre-op (n=11)	1. month (n=10)	1 year (n=10)	p
EF %	55.91±7.69	52.86±8.88	53.51±7.09	0.771 ^a 0.808 ^b 0.771 ^c
Annulus Diameter (mm)	44 (40-52)	45 (38-46)	42 (38-47)	0.051 ^a 0.006 ^b 0.337 ^c
NYHA	4 (3-4)	1 (1-2)	1 (1-2)	0.004 ^a 0.004 ^b 0.157 ^c
TAPSE (mm)	19.64±2.94	18.51±2.88	19.23±2.91	0.333 ^a 1.00 ^b 0.332 ^c
PAP (mmHg)	42.73±12.52	35.10±8.45	30.50±9.26	0.150 ^a 0.048 ^b 1.00 ^c
LVESD (mm)	34.27±6.26	33.80±5.43	33.60±5.68	0.198 ^a 0.182 ^b 1.00 ^c
LVEDD (mm)	52.36±5.61	50.80±4.76	49.80±6.16	0.134 ^a 0.105 ^b 1.00 ^c
RA Diameter (mm)	54.45±10.98	50.30±11.05	48.50±9.66	0.019 ^a 0.001 ^b 0.036 ^c
RV Diameter (mm)	43.27±7.71	37.63±4.25	37.86±4.59	0.035 ^a 0.035 ^b 1.00 ^c

a: Comparison of preoperative and 1st month results; b: Comparison of preoperative and 1st year results; c: Comparison of postoperative 1st month and 1st year results. EF: Ejection Fraction, NYHA: New York Heart Association Classification, TAPSE: Tricuspid Annular Plane Systolic Excursion, PAP: Pulmonary Artery Pressure, LVESD: Left Ventricular End-Systolic Diameter, LVEDD: Left Ventricular End-Diastolic Diameter, RA Diameter: Right Atrium Diameter, RV Diameter: Right Ventricle Diameter

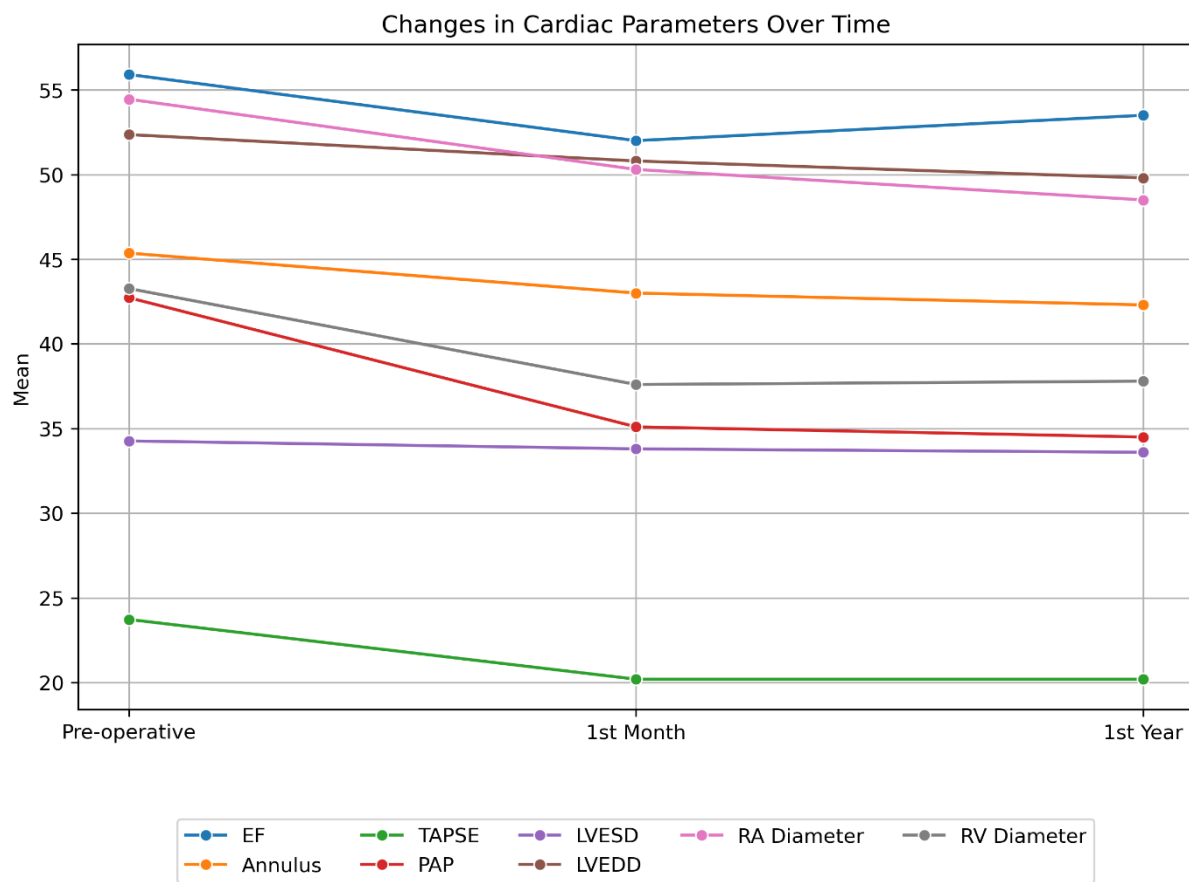


Figure 1. Changes in measurements over time

Discussion

Our most important finding was the low in-hospital mortality among patients undergoing isolated tricuspid valve surgery and significant postoperative improvements in PAP and NYHA functional class. According to a systematic meta-analysis, early mortality in isolated tricuspid valve surgeries is approximately 9%, while late mortality reaches around 27% at four years (6). The early mortality rate of 9.10% observed in our cohort is consistent with these findings, and our mid-term mortality results were more favorable than those reported in the literature.

For many years, the tricuspid valve has been referred to as the "forgotten valve"—often considered only in conjunction with other valve pathologies, and surgical intervention was frequently avoided, whether isolated or combined. This was mainly due to the belief that tricuspid regurgitation (TR) would improve following left-sided valve surgery, as well as the disease's often asymptomatic course, its nonspecific symptoms, and the poor prognosis associated with delayed surgery (7).

Once TR becomes symptomatic, it significantly impairs patients' quality of life and exercise capacity. Leaving patients to cope with progressive TR seems

unjustified when compared to the potential benefits of surgical intervention. Our study's acceptable early mortality and highly favorable mid-term outcomes demonstrate that surgical treatment is a far more appropriate approach than continued symptomatic management.

In our cohort, all patients had severe (grade 4) TR at the time of surgery. This suggests that surgery is typically not considered until significant valve dysfunction has occurred and highlights the lack of consensus or guidance regarding intervention in patients with lesser degrees of TR.

Previous studies have shown that delayed surgical intervention in TR patients significantly increases postoperative mortality. Elgharably et al. emphasized that late surgery is associated with irreversible complications such as right ventricular (RV) dysfunction, systemic congestion, and hepatic injury (8). In our clinic, the most critical parameter guiding the decision for tricuspid valve surgery is the patient's tricuspid annular plane systolic excursion (TAPSE) value. Surgical treatment is recommended for patients with TAPSE ≥ 13 mm, whereas those with lower TAPSE values are generally not considered for surgery. We believe that this selection criterion significantly contributed to our

favorable results. Yajima et al. showed that a TAPSE value <15 mm is associated with a high-risk profile and substantially correlates with postoperative mortality (9, 10). Therefore, it is crucial to intervene before a substantial decline in TAPSE occurs.

In our study, valve repair (ring annuloplasty) was performed in 63.6% of patients, and valve replacement in 36.4%. Literature recommends valve repair when feasible, as the long-term success of bioprosthetic or mechanical valves in the low-pressure right-sided circulation remains controversial (11). However, in anatomically unsuitable cases, replacement is unavoidable.

Although a slight decrease in TAPSE was observed postoperatively, the values remained within a range indicating preserved RV function. Numerous studies have emphasized that the right ventricle is more sensitive to volume overload and that RV dysfunction, particularly when caused by TR, is an independent predictor of mortality (12). In our study, significant reductions in RV and right atrial (RA) diameters postoperatively, along with preserved TAPSE values, suggest a beneficial effect on mortality and clinical recovery.

A significant reduction in PAP was observed as early as the first postoperative month, which remained stable at the 1-year follow-up. This indicates effective control of pulmonary hypertension following surgery and decreased pressure and volume load on the RV. This finding is consistent with the observations of Mascherbauer et al., who reported that RV afterload and PAP independently influence clinical outcomes regardless of the severity of TR (13).

Significant improvements in NYHA class were observed from the first postoperative month, reaching highly substantial levels by the end of the first year. This supports the notion that surgery provides hemodynamic improvement and significantly enhances quality of life. Similar findings have been reported by Dreyfus et al.,

who demonstrated that NYHA Class III–IV patients improved to Class I–II after surgery (11).

The major strength of our study is that it exclusively evaluated patients undergoing isolated tricuspid valve surgery. This eliminated the potential influence of concomitant valve procedures or other interventions on the outcomes. However, limitations include the retrospective study design, the small sample size, and the lack of long-term (>1 year) follow-up data. To more accurately assess the long-term success of right-sided heart surgery, prospective, multicenter studies are needed.

In conclusion, isolated tricuspid valve surgery is a viable treatment option that can be performed with low morbidity and mortality rates in experienced centers. Significant hemodynamic and symptomatic improvements were observed during the one-year follow-up of patients who underwent tricuspid valve surgery. The PAP and NYHA functional class showed marked improvement over this period. Mortality occurred in only one patient.

Therefore, in patients with symptomatic tricuspid regurgitation - whether or not they have undergone prior cardiac surgery - surgical intervention should be considered without unnecessary delay. Randomized prospective studies with larger patient populations are needed to obtain more definitive conclusions.

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