



Concomitant tricuspid valve regurgitation repair in patients with minimally invasive mitral valve surgery: a single-centre experience in Vietnam

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Background: This study aims to present the early and mid-term outcomes of combining minimally invasive mitral valve surgery (MIMVS) with tricuspid valve repair (TVR) at the authors' centre.

Methods: From January 2017 to March 2022, our centre treated a total of 67 patients with both MIMVS and TVR. Among these patients, 41 were women (61.2%), and 26 were men (38.8%). The average Euro SCORE II was $2.67 \pm 1.54\%$, and the patients had an average follow-up period of 25.45 ± 16.2 months.

Results: Pre-discharge echocardiography revealed no or mild TR in 82.8% of cases. The overall 30-day mortality rate was 4.5%, with 3 deaths. Five-year survival was $94.5\% \pm 3.2\%$. In patients with mild or moderate preoperative tricuspid regurgitation (TR), the 5-year survival rate was $95.7\% \pm 4.3\%$, while for those with severe TR, it was $93.7\% \pm 4.5\%$ ($P = 0.947$).

Conclusions: The authors' 5-year experience demonstrates that the combination of MIMVS and TVR can be routinely performed with favourable perioperative and postoperative outcomes in patients undergoing non-high-risk surgery. Additionally, there is no significant difference in five-year survival between the severe TR and mild to moderate TR groups preoperatively.

Keywords: minimally invasive mitral valve surgery (MIMVS), tricuspid valve repair (TV)

Introduction

When there are specific indications, concurrent tricuspid valve repair surgery alongside mitral valve surgery is advised in accordance with the latest guidelines from the American College of Cardiology (ACC) 2020 and the European Society of Cardiology (ESC) 2021^{1,2}. In line with the growing trend toward less invasive cardiac procedures, many centres are now undertaking minimally invasive mitral valve surgery (MIMVS) in conjunction with tricuspid valve repair (TVR) and reporting commendable outcomes^{3–5}. In 2014, our centre initiated MIMVS procedures and subsequently began to perform them alongside TVR^{6,7}. Our study, therefore, aims to present the

HIGHLIGHTS

- This study explores the outcomes of combining minimally invasive mitral valve surgery (MIMVS) with tricuspid valve repair (TVR) at our centre.
- Notably, pre-discharge echocardiography revealed no or mild tricuspid regurgitation (TR) in 82.8% of cases, highlighting the success of the combined approach.
- With a 4.5% 30-day mortality rate and a five-year survival rate of $94.5\% \pm 3.2\%$, the study demonstrates favourable perioperative and postoperative results for patients undergoing this non-high-risk surgical combination.

early and mid-term results of MIMVS combined with TVR at our centre.

Methods

During the period from January 2017 to March 2022, our centre conducted a cross-sectional study in which a total of 67 patients were treated for both MIMVS and TVR. This treatment adhered to the guidelines set by the ACC in 2020 and the ESC in 2021. Among these patients, 41 were women (61.2%), and 26 were men (38.8%).

Preoperative, intraoperative, and postoperative data were diligently recorded and subsequently entered into our patient data management system for retrospective analysis. Additionally, a comprehensive review of patient charts was performed, and information was collected from preoperative and pre-discharge echocardiographic reports for in-depth analysis. The quantification of

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mitral regurgitation (MR) and tricuspid regurgitation (TR) was achieved through the measurement of the vena contracta in the four-chamber view.

Our centre has previously described the minimally invasive technique for both mitral valve and tricuspid valve surgery through a right anterolateral mini-thoracotomy^{17–91}. The choice of technique for repair was influenced by the operating surgeon's discretion and preoperative echocardiographic findings.

This study has been conducted following the STROCSS criteria¹¹⁰.

The study has been registered in the Research Registry under the number researchregistry9992 and received approval from our hospital's ethics committee with the approval number 618/HDDD-DHYD.

Inclusion and exclusion criteria

Inclusion

Incorporates all patients from January 2017 to March 2022 who underwent both MIMVS and TVR.

The procedures are conducted by a sole primary surgeon highly specialized in cardiovascular surgery, with additional support provided by skilled assistants.

Exclusion

Redo MIMVS and TVR

Patients with endocarditis

Clinical outcomes

The primary outcomes included adverse clinical events, such as all-cause death and reoperation on operated valves. The secondary outcome centred on the incidence of severe TR assessed through echocardiography during the follow-up period.

Follow-up

Contact was established with all patients either through outpatient appointments or direct telephone communication. In cases where no further information was available, family physicians and referring cardiologists were proactively contacted. The mean follow-up time was 25.45 ± 16.2 months (ranging from 1 to 52 months).

Statistical evaluation

The standard format is used for presenting results, with continuous variables expressed as mean \pm standard deviation, and categorical data presented as proportions throughout the manuscript. Cumulative survival was determined using Kaplan–Meier methods. Differences in follow-up were calculated with 95% confidence limits and compared using the log-rank (Mantel–Cox) test. All statistical analyses were carried out using Stata statistical package version 17.0 (StataCorp LLC). Statistical significance was set at a *P* value less than 0.05.

Results

Demographic data

A total of 67 patients underwent concurrent MIMVS and TVR. The average age of the patients was 54.5 ± 11.3 years. The calculated risk of surgical mortality according to the Euro Score II

Table 1

Preoperative patient variables.

	<i>N</i>	%
Age (years)	54.5 ± 11.3	
Female	41	61.2
Smoke	20	29.9
Secondary TR	44	65.7
Primary and secondary TR	23	34.3
Diabetes mellitus	6	9
COPD	2	3
Previous balloon mitral valvotomy	5	25.5
Atrial fibrillation	28	41.8
Renal failure	11	16.5
Mild and moderate TR	23	34.3
Severe TR	44	65.7
Euro Score II	$2.67 \pm 1.54\%$	
Mitral valve disease		
Mitral stenosis (MS)	22	32.8
Mitral regurgitation (MR)	21	31.4
MS and MR	24	35.8

COPD, Chronic obstructive pulmonary disease; TR, tricuspid regurgitation.

scale averaged $2.67 \pm 1.54\%$. Women comprised 61.2% of the patient population, and 65.7% of patients presented with secondary tricuspid regurgitation, of which 65.7% had severe TR. A history of previous balloon mitral valvotomy was noted in 25.5% of patients. Mitral valve disease is described in Table 1.

The average aortic clamping time was 111.3 ± 21.8 minutes, and the cardiopulmonary bypass (CPB) time averaged 167.7 ± 36.2 min. Accompanying diseases and conditions are detailed in Table 1. Among the patients, 11 (16.4%) experienced valve repair with cleft closure, 5 (7.5%) underwent valve annuloplasty with pericardium, and 62 (92.5%) received tricuspid valve ring annuloplasty (Table 2). Various accompanying surgical procedures were performed, with mitral valve replacement being the primary procedure (83.6%). Concurrent surgeries included MAZE surgery in 28 patients (41.8%) and surgery to repair atrial septal defects in 4 patients.

Perioperative outcomes

The overall 30-day mortality rate was 4.5% with three reported deaths. One patient (1.5%) required postoperative reoperation due to bleeding. At the 6-month follow-up visit, two cases of severe tricuspid valve regurgitation were detected during ultrasound monitoring. Additional complications are detailed in

Table 2

Operative techniques.

	<i>N</i>	%
Mitral valve		
Mitral valve repair	11	16.4
Mitral valve replacement	56	83.6
Bioprosthetic valve	33	49.3
Mechanical valve	23	34.3
Tricuspid valve		
TR repair with cleft closure	11	16.4
Annuloplasty with pericardium	5	7.5
TR ring annuloplasty	62	92.5

TR, tricuspid regurgitation.

Table 3
Postoperative outcomes (N=67).

30-day mortality, n (%)	3 (4.5)
Length of postoperative stay (days) median (interquartile range)	19.0 (9.0–43.0)
Reoperation for bleeding, n (%)	1 (1.5)
Stroke, n (%)	2 (3)
Acute renal failure, n (%)	12 (17.9)
Pacemaker requirement, n (%)	3 (4.5)
Severe TR postoperative, n (%)	2 (3)

TR, tricuspid regurgitation.

Table 3. Echocardiography conducted 1 month after surgery revealed that 53 patients (82.8%) had mild TR. Changes in echocardiographic findings preoperatively and postoperatively are presented in Table 4.

Survival outcomes

The overall 5-year survival rate for all patients stood at 94.5% ± 3.2% (Fig. 1). There was no statistically significant difference in survival between patients with severe TR before surgery and those in the non-severe TR group (P=0.947, Fig. 2). Patient survival remained unaffected by the preoperative grade of tricuspid regurgitation. After more than 5 years of follow-up, the cumulative incidence for no moderate and severe TR reached 83.6% ± 4.5% (Fig. 3).

Discussion

Secondary TR is frequently observed in our patients, primarily stemming from the progression of mitral valve disease, constituting 65.7% of cases. The remaining cases involve a combination of secondary and primary mechanisms, often attributed to post-rheumatic causes. When addressing mitral valve surgery, our predominant approach involves valve replacement, accounting for 83.6% of cases. This procedure is performed expeditiously, affording us the opportunity to subsequently address tricuspid valve repair. In the later stages of the study, as our efficiency increased, we opted for a combined approach of mitral valve repair and tricuspid valve repair, constituting 16.4% of cases.

The minimally invasive mitral valve and TVR surgery demonstrate safety and effectiveness with acceptable aortic clamping and CPB times when compared to full sternotomy procedures^[5,11]. Following surgery, our results revealed no instances of severe tricuspid valve regurgitation 1 month postoperatively. Moreover, there was a statistically significant reduction in cases of moderate or severe tricuspid valve regurgitation at the 1-month follow-up. Notably, no cases necessitated reoperation, and although two

Table 4
Changes in echocardiographic findings before and after surgery.

	Preoperative	1 month postoperative	p
Moderate or severe TR	90.6%	17.2%	< 0.0001
Left ventricular ejection fraction (LVEF)	58.0 + 7.7%	53.6 + 8.4%	0.001
Right ventricular fractional area change (RVFAC)	34.7 + 8.5%	36.8 + 7.3%	0.069

TR, tricuspid regurgitation.

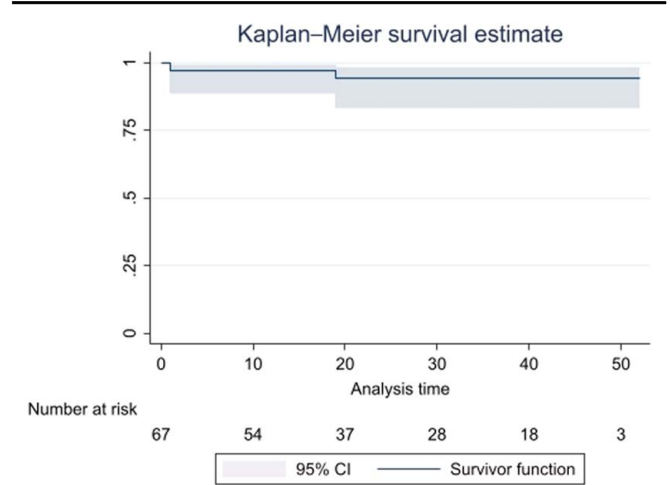


Figure 1. Kaplan–Meier estimated survival for all patients.

patients presented with severe tricuspid valve regurgitation at the 6-month follow-up, they remained asymptomatic with no signs of right ventricular failure in echocardiography. These patients responded well to medical treatment, and it’s worth mentioning that they initially had severe tricuspid valve regurgitation before surgery. Our mortality rate stands at 4.5%, and aortic clamping time, extracorporeal circulation time, and postoperative complications are comparable to those reported by other authors worldwide^[5,12]. Our results affirm that the combination of MIMVS surgery and TVR yields positive and safe outcomes, in line with findings from other authors internationally.

The five-year survival rate in our patient cohort stands at 94.5% ± 3.2%, which is relatively higher when compared to findings from other authors^[5,11,12]. This difference can be attributed to our careful patient selection process, as we chose individuals with a lower preoperative risk of mortality calculated according to the Euro Score II scale. This underscores our commitment to the prudent application of minimally invasive procedures for patients undergoing multiple surgeries simultaneously, with a primary focus on ensuring patient safety.

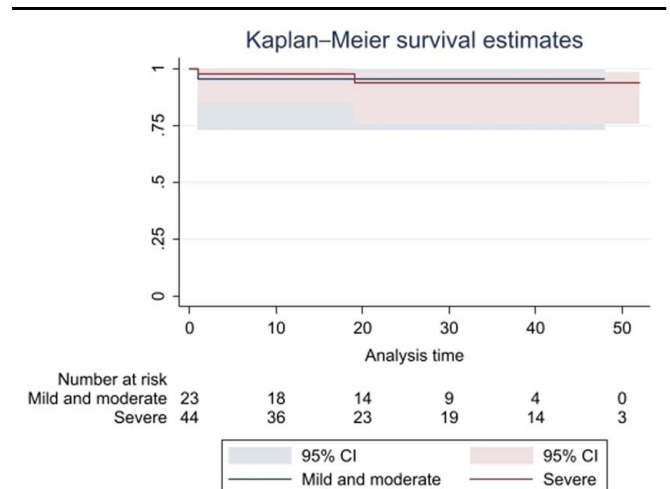


Figure 2. Kaplan–Meier estimated survival for patients with preoperative severe tricuspid regurgitation (TR) vs. non-severe TR.

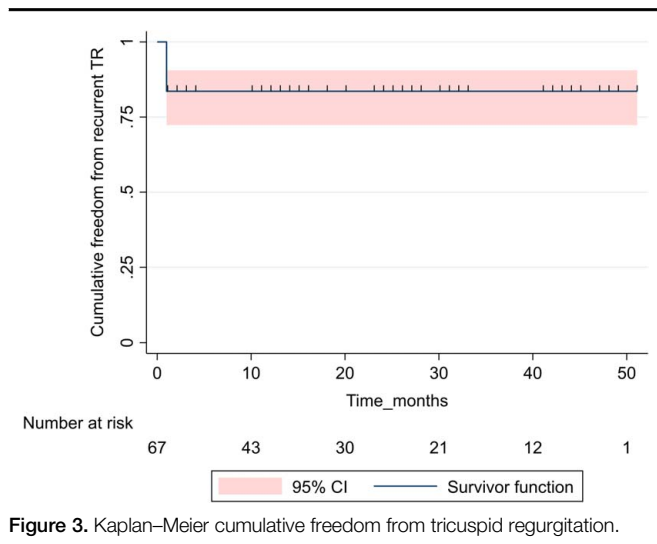


Figure 3. Kaplan-Meier cumulative freedom from tricuspid regurgitation.

This represents the culture of care at our centre for patients^[6]. Furthermore, after more than five years of follow-up, the cumulative incidence for no moderate and severe TR reached $83.6\% \pm 4.5\%$, aligning closely with findings reported by other authors worldwide. This similarity emphasizes the reasonableness of our results, especially when considering our minimally invasive approach^[13].

According to the latest guidelines from the ACC and the ESC, the recommendation is to consider TVR surgery, along with left heart valve surgery when indicated, due to the associated improvement in both survival rates and long-term prognosis^[1,2,14]. These guidelines include not only severe tricuspid valve regurgitation as an indication but also consider other factors such as dilated valve annulus, right ventricular failure, or clinical symptoms. Our results indicate that there is no significant difference in survival between the group of patients with severe TR before surgery and the non-severe TR group. This suggests that the simultaneous treatment of the tricuspid valve based on the recommendations outlined above is indeed appropriate.

A study conducted by Pfannmüller *et al.* demonstrated that patients in the TR level 3 or 4 group exhibited a statistically significant lower survival rate compared to those in the TR level 1 or 2 group^[5]. Interestingly, our study yields different results. It's possible that our patients had a lower surgical risk based on their Euro Score II assessment compared to the patients in the study by Pfannmüller, even though cross-clamp and CPB times were relatively similar. Moreover, research has consistently shown that TVR using a ring annuloplasty technique produces superior outcomes when compared to suture annuloplasty methods^[5,14,15]. In our study, 100% of our patients underwent annulus ring or annuloplasty with pericardium, contributing to improved treatment outcomes compared to studies that employed annulus suture techniques.

Study limitations

This is a single-centre retrospective study, and a small number of patients were treated. A longer follow-up is needed to confirm long-term results and TR repair durability.

Conclusion

The safety and effectiveness of simultaneous minimally invasive mitral valve and tricuspid valve repair surgeries at our centre are supported by our experience. Similar 5-year survival rates were observed in our patients compared to those reported by other authors. Importantly, it was found that, when appropriate indications are followed, and the surgical risk is not high, the degree of tricuspid valve regurgitation before surgery does not have a significant impact on patient survival.

Ethical approval

This study was reviewed and approved by the Institutional Review Board at University Medical Center, University of Medicine and Pharmacy at Ho Chi Minh city (approval number: 618/HDDD-DHYD). All methods were performed in accordance with the Declaration of Helsinki.

Patient anonymity and informed consent

I declare that this manuscript contains absolutely no information that can identify the patient.

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Author contribution

Data collection and writing: L.C.H. and N.H.D. Critical review and revision: P.Q.T. and N.H.D. Final approval of the article: all authors. Accountability for all aspects of the work: all authors.

Conflicts of interest disclosure

The authors declare no conflict of interest in preparing this article.

Research registration unique identifying number (UIN)

The study is registered on researchregistry.com with code researchregistry9992. Link: <https://researchregistry.knack.com/researchregistry#userresearchregistry/registerresearchdetails/65c246cd5f498900298f6875/>

Guarantor

Nguyen Hoang Dinh.

Availability of data and materials

All of the materials are available and owned by the authors and/or no permissions are required.

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