Safety and efficacy of transcatheter mitral valve repair in patients with COPD; results from real-world cohort

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Abstract

Objective: To evaluate the safety and efficacy of transcatheter mitral valve repair (TMVR) in patients with chronic obstructive pulmonary disease (COPD).

Background: Heart failure and COPD share many clinical features and commonly coexist. Data about the safety and efficacy of TMVR in patients with COPD is not conclusive.

Methods: Three hundred and forty consecutive patients undergoing TMVR were retrospectively included. COPD diagnosis was based on pulmonary function tests (PFTs). Intra-hospital, 30-day- and 1-year outcomes were compared between both groups.

Results: Eighty-two patients had COPD (24%). There was no difference in in-hospital mortality between patients with and without COPD (both 5%, p = 0.95). Among patients who had a successful procedure and survived to discharge there was a trend toward more rehospitalization due to decompensated heart failure at 30-day follow-up in patients with COPD (12.9% vs. 6.8%, p = 0.08) with no difference in mortality. At median follow-up of 1 year, New York heart association (NYHA) category was comparable among both groups and there was no significant difference in rehospitalization (COPD: 29.9% vs. non-COPD: 34%, p = 0.5). There was a trend toward increased 1-year mortality in COPD patients (31.2% vs. 20.6%, p = 0.06). However, a composite endpoint of rehospitalization or death at 1 year did not differ between both groups (48% vs. 42.5%, p = 0.4). Regression analysis showed no correlation between COPD severity and worse TMVR outcomes.

Conclusions: COPD is highly prevalent among patients undergoing TMVR. However, TMVR seems to be safe and effective in COPD patients. COPD severity and PFT impairment alone should not be considered as a contraindication for TMVR.

Abbreviations: COPD, chronic obstructive pulmonary disease; FEV1, forced expiratory volume in 1 s; GOLD, global initiative for obstructive lung disease; MR, mitral regurgitation; NYHA, New York heart association; PFT, pulmonary function test; RV, residual volume; TLC, total lung capacity; TMVR, transcatheter mitral valve repair; VC, vital capacity.

Mohammad Almalla and Ayham Daher contributed equally to this study.

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INTRODUCTION

Chronic obstructive pulmonary disease (COPD) and cardiovascular disease represent major causes of morbidity and mortality worldwide. Both diseases share a lot of clinical features and commonly coexist, and their coexistence is associated with worse prognosis. Among valvular heart diseases, mitral regurgitation (MR) is the most common disorder, which worsens patient’s quality of life and prognosis. However, a growing body of evidence shows that COPD is associated with increased morbidity and mortality in patients undergoing cardiac surgery including those undergoing mitral valve surgery. Nevertheless, patients with high surgical risk could benefit from transcatheter mitral valve repair (TMVR) which has emerged as an alternative to surgery for symptomatic severe MR, and which has been shown to be superior to medical therapy alone in patients with heart failure. However, data about the safety and efficacy of TMVR in patients with COPD are diverse. A post hoc analysis of the cardiovascular outcomes assessment of the MitraClip precutaneous therapy (COAPT) Trial showed that TMVR provided only symptomatic but no survival benefit in patients with COPD. Nevertheless, in the analysis, the diagnosis of COPD was based mainly on medical records whereas pulmonary function tests (PFTs) were not routinely performed. This is a significant limitation because underlying COPD can be undiagnosed in many patients, and 20%–50% of those with self-reported COPD do not fulfill spirometric disease criteria.

Therefore, this study aimed to investigate the prevalence of COPD, confirmed by PFTs, in a cohort of TMVR candidates and to compare TMVR outcomes in COPD patients against patients without COPD. Furthermore, we investigated associations between PFT variables and outcomes after TMVR in COPD patients.

MATERIALS AND METHODS

Patients’ selection

All consecutive patients who received TMVR between January 01, 2014 and December 31, 2019 at the university hospital RWTH of Aachen were retrospectively included (Figure 1). All patients had symptomatic severe MR as defined by the guidelines of European Society of Cardiology and European Association of Cardiovascular Imaging. All patients were evaluated by the multidisciplinary heart team during primary investigation and were deemed to be inoperable. In all cases, the multidisciplinary heart team recommended to proceed with TMVR. Recommended criteria for selecting patients who are suitable to TMVR are reported elsewhere. All patients received PFTs during primary investigation, which is a mandatory part of standard operating procedures (SOPs) at our institution. Whole-body plethysmography (MasterLab, Viasys) was performed before and after bronchodilation according to current guidelines and recommendations. Samples for ABG were taken from the arterialized earlobes of all patients while breathing room air without supplemental oxygen (ABL 800 flex, Radiometer). Patients were stratified into the two following subgroups: Presence of COPD versus no COPD, according to the Global Initiative for Obstructive Lung Disease (GOLD) criteria.

The protocol for this retrospective study was approved by the local ethics committee (EK 396/20), and the study was performed in accordance with the ethical standards laid down in the Declaration of Helsinki in its latest revision.

TMVR

All procedures were performed under general anesthesia using the MitraClip® device (Abbott Vascular Structural Heart, Menlo Park, California) under guidance of fluoroscopy and transesophageal echocardiography by an experienced interventional cardiologist. The steps of performing TMVR are described in detail elsewhere.

Follow-up and definition of outcomes

Intra-hospital outcomes included success of the procedure defined as successful implantation of at least one clip and reduction of severe MR to maximally moderate MR, vascular complications defined as arteriovenous fistula, pseudoaneurysm, or relevant bleeding requiring operative or interventional management and intra-hospital mortality. Thirty-day- and 1-year outcomes were evaluated in patients who had a successful procedure and who survived to discharge. Outcome endpoints included New York heart association (NYHA) dyspnea category, rehospitalization due to acute decompensated heart failure, all cause-mortality, and a composite endpoint of 1-year rehospitalization or all-cause mortality of all patients. MR severity at follow-up was also assessed in patients with available echocardiographic follow-up.

Follow-up data were obtained from patient’s medical records. Patients who did not have 1-year follow-up data in our patient data management system were contacted per telephone and asked about their symptoms (NYHA dyspnea category or need of rehospitalization). Regarding patients who have not been reached, the primary care physician was contacted. In patients who needed rehospitalization, the cause of rehospitalization was investigated from the medical charts or through primary care physician. In patients who did not survive, date of death was obtained through their primary care physician.
Continuous variables were expressed as mean ± standard deviation and binary variables were expressed as count (percentage). Continuous variables were compared with independent t test, categorical variables were assessed by Pearson’s χ² test. To assess the association of COPD presence and its severity (expressed as GOLD grade as well as with individual PFT variables) with outcomes, we performed univariate logistic regression analysis for each of these parameters. Statistical analyses were performed with SPSS version 25.0 (IBM Corp.). Statistical significance was awarded by p < 0.05.

4.2 | Intra-hospital outcomes

The procedure was successfully completed with implantation of at least one clip and reduction of MR to maximally moderate MR in 95.3% of patients. There was no significant difference regarding procedure success between patients with and without COPD (97.6% vs. 94.6%, p = 0.27). In addition, intra-hospital mortality did not significantly differ between both groups (4.9% vs. 5%, p = 0.95) (Table 3). As well, there was no difference between patients with no COPD and those with severe to very severe COPD (GOLD 3 or 4) regarding intra-hospital outcomes (Table 3).

4.3 | 30-day and 1-year outcomes

A total of 312 patients who had a successful procedure and survived to discharge were included in the analysis. Thirty-day mortality did not differ between patients with and without COPD. However, there was a trend toward more 30-day rehospitalization in patients with COPD, without reaching statistical significance (12.9% vs. 6.8%, p = 0.08) (Table 4). At median follow-up of 1-year (interquartile range [IQR]: 6-16 months), NYHA category was similar in patients with and without COPD (2.2 ± 0.7 vs. 2.3 ± 0.8, p = 0.38) (Table 4). Besides, there was no significant difference in the proportion of patients needing rehospitalization at 1 year due...
TABLE 1  Clinical characteristics and echocardiographic parameters of the study population

|                          | All (n = 340) | COPD (n = 82) | Severe/very severe COPD (n = 26) | Non-COPD (n = 258) | p value<sup>a</sup> | p value<sup>b</sup> |
|--------------------------|--------------|--------------|----------------------------------|--------------------|--------------------|--------------------|
| **Clinical characteristics** |              |              |                                  |                    |                    |                    |
| Age, year                | 76.7 ± 8.2   | 75.2 ± 8.7   | 72.0 ± 10.0                      | 77.1 ± 8.0         | 0.08               | 0.02               |
| Male, n (%)              | 218 (64.1)   | 57 (69.5)    | 21 (80.8)                        | 161 (62.4)         | 0.26               | 0.06               |
| Primary MR, n (%)        | 98 (28.8)    | 19 (23.2)    | 9 (34.6)                         | 79 (30.6)          | 0.20               | 0.68               |
| ICM, n (%)               | 180 (52.9)   | 29 (35.4)    | 12 (46.2)                        | 130 (50.4)         | 0.07               | 0.86               |
| Previous CABG, n (%)     | 82 (24.1)    | 17 (20.7)    | 6 (23.1)                         | 65 (25.2)          | 0.64               | 0.29               |
| Previous PCI, n (%)      | 166 (48.8)   | 27 (32.9)    | 7 (26.9)                         | 139 (53.9)         | 0.40               | 0.06               |
| DM, n (%)                | 106 (31.2)   | 23 (28)      | 5 (19.2)                         | 83 (32.2)          | 0.51               | 0.22               |
| HTN, n (%)               | 266 (78.2)   | 59 (72)      | 18 (69.2)                        | 207 (80.2)         | 0.13               | 0.36               |
| Atrial fibrillation, n (%) | 239 (70.3) | 56 (68.3) | 17 (65.4) | 183 (70.9) | 0.69 | 0.80 |
| eGFR<60 ml/min, n (%)    | 225 (66.2)   | 55 (67.1)    | 14 (53.8)                        | 170 (65.9)         | 0.82               | 0.32               |
| Dialysis, n (%)          | 18 (5.3)     | 6 (6.1)      | 2 (7.7)                          | 13 (5.0)           | 0.70               | 0.52               |
| PAD                      | 85 (25)      | 25 (30.5)    | 6 (23.1)                         | 60 (23.3)          | 0.44               | 0.89               |
| Logistic EuroScore       | 25.1 ± 13.5  | 27.3 ± 13.4  | 23.7 ± 13.8                      | 24.5 ± 13.6        | 0.10               | 0.79               |
| NYHA category, mean      | 3.11 ± 0.63  | 3.07 ± 0.60  | 3.17 ± 0.67                      | 3.12 ± 0.64        | 0.60               | 0.73               |
| KATZ index               | 4.3 ± 0.8    | 4.3 ± 0.7    | 4.2 ± 0.8                        | 4.3 ± 0.8          | 0.85               | 0.74               |
| NYHA category            |              |              |                                  |                    | 0.47               | 0.93               |
| I                        | 0            | 0            | 0                                | 0                  |                    |                    |
| II                       | 40 (11.8)    | 8 (9.8)      | 3 (11.5)                         | 32 (12.4)          |                    |                    |
| III                      | 193 (56.8)   | 48 (58.5)    | 12 (46.2)                        | 145 (56.2)         |                    |                    |
| IV                       | 107 (31.5)   | 26 (31.7)    | 9 (34.6)                         | 81 (31.4)          |                    |                    |
| **Imaging characteristics** |              |              |                                  |                    |                    |                    |
| EF, %                    | 39.6 ± 13.6  | 38.9 ± 13.8  | 43.9 ± 13.3                      | 39.8 ± 13.5        | 0.64               | 0.15               |
| LVEDD, mm                | 57.3 ± 9.5   | 58.8 ± 9.7   | 57.7 ± 11.1                      | 56.9 ± 9.4         | 0.18               | 0.76               |
| LVESD, mm                | 46.2 ± 12.6  | 47.6 ± 13.2  | 43.6 ± 13.2                      | 45.7 ± 12.4        | 0.35               | 0.52               |
| EROA, mm²                | 34.6 ± 16    | 34 ± 15      | 38 ± 15                          | 34.8 ± 16.5        | 0.74               | 0.48               |
| RVOL, ml                 | 54.3 ± 22    | 56.1 ± 26    | 63.5 ± 34.8                      | 53.8 ± 21.1        | 0.53               | 0.08               |
| LA area, cm²             | 29.8 ± 9.6   | 30.1 ± 12.6  | 37.0 ± 20.7                      | 29.7 ± 8.6         | 0.79               | 0.20               |
| RA area, cm²             | 24.6 ± 8.3   | 24.6 ± 11.6  | 31.1 ± 18.4                      | 23 ± 7.1           | 0.34               | 0.11               |
| TR                       |              |              |                                  |                    | 0.75               | 0.92               |
| Mild                     | 139 (40.9)   | 38 (46.3)    | 10 (38.5)                        | 101 (39.1)         |                    |                    |
| Moderate                 | 162 (47.7)   | 23 (28)      | 4 (15.4)                         | 139 (53.9)         |                    |                    |
| Severe                   | 39 (11.5)    | 21 (25.6)    | 5 (19.2)                         | 18 (7)             |                    |                    |
| sPAP, mmHg               | 43.6 ± 15.6  | 47.3 ± 14.3  | 45.1 ± 16.5                      | 44.3 ± 14.2        | 0.76               | 0.43               |
| TAPSE, mm                | 16.1 ± 3.2   | 16.2 ± 3.3   | 16.6 ± 3                         | 15.9 ± 3.2         | 0.58               | 0.38               |

Note: Values are presented as mean ± standard deviation or the number of patients (%).
Abbreviations: CABG, coronary artery bypass graft; COPD, chronic obstructive pulmonary disease; MR, mitral regurgitation; ICM, ischemic cardiomyopathy; PCI, percutaneous coronary intervention; DM, diabetes Mellitus; HTN, arterial hypertension; eGFR, estimated glomerular filtration rate; PAD, peripheral artery disease; NYHA, New York heart association; EF, ejection fraction; LVEDD, left ventricular end diastolic diameter; LVESD, left ventricular end systolic diameter; EROA, effective regurgitant orifice area; RVOL, regurgitant volume; LA, left atrium; RA, right atrium; TR, tricuspid regurgitation; sPAP, systolic pulmonary artery pressure; TAPSE, tricuspid annular plane systolic excursion.

<sup>a</sup>COPD vs. non-COPD.
<sup>b</sup>Severe/very severe COPD vs. non-COPD.
to decompensated heart failure between COPD- and non-COPD groups (29.9% vs. 34%, p = 0.5). There was a trend toward increased 1-year all-cause mortality in patients with COPD without reaching statistical significance (31.2% vs. 20.6%, p = 0.06). A composite endpoint of rehospitalization due to acute heart failure or death was also comparable in both groups (48% vs. 42.5%, p = 0.4) (Table 4). As well, there was no difference between patients with no COPD and those with severe to very severe COPD (GOLD 3 or 4) regarding intrahospital, 30-day, and 1-year outcomes (Table 4).

Echocardiographic follow-up data were available in 220 patients. In those patients, the severity of MR at follow-up did not differ between groups as well (Table 4).

Regression analysis confirmed the trend toward an association of the presence of COPD with increased all-cause mortality whereas an effect of coexisting COPD on other outcomes was not observed (Table 5). Neither the severity of COPD expressed as GOLD stage nor different PFT variables such as forced expiratory volume in 1 s (FEV1), vital capacity (VC), or hyperinflation expressed as residual volume/total lung capacity (RV/TLC) were associated with adverse outcome in COPD patients (Table 5). Furthermore, regression analysis showed a trend toward an association between the severity of tricuspid regurgitation and increased mortality. Detailed results of regression analysis are reported in Table 4.

### 5 Discussion

This study showed that COPD is highly prevalent in patients undergoing TMVR. Despite a trend toward an increased 1-year mortality in COPD patients, the presence of COPD was not associated with worse intra-hospital or 1-year outcome. Severity of COPD expressed as advanced GOLD stage or severe PFT impairments were not associated with unfavorable outcomes in patients with COPD.

### Table 2 Medical therapy and pulmonary function tests of COPD patients

| Variable                          | COPD patients (n = 82) |
|-----------------------------------|------------------------|
| GOLD stage, n (%)                 |                        |
| 1                                 | 5 (5)                  |
| 2                                 | 51 (62)                |
| 3                                 | 23 (28)                |
| 4                                 | 3 (6)                  |
| TLC, % of predicted               | 100 ± 22               |
| VC, % of predicted                | 74 ± 16.7              |
| RV, % of predicted                | 148 ± 47               |
| RV/TLC, %                        | 138 ± 19               |
| FEV1, % of predicted              | 57.3 ± 15              |
| Tiffeneau index (FEV1/FVC), %     | 60 ± 9                 |

**Blood gas analysis**

- **PaO2, mmHg**: 64 ± 8
- **PaCO2, mmHg**: 37 ± 4
- **PH**: 7.44 ± 0.03
- **Base excess**: 1.9 ± 2.3

**Use of inhaled bronchodilators (LABA, LAMA), n (%)**

- 51 (62)

**Use of inhaled corticosteroid, n (%)**

- 13 (16)

**Use of systemic corticosteroid, n (%)**

- 5 (6)

**Use of LTOT therapy, n (%)**

- 2 (2.5)

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**Table 3 Intrahospital outcomes of TMVR in patients with COPD and without COPD**

|                              | All (n = 340) | COPD (n = 82) | Severe/very severe COPD (n = 26) | Non-COPD (n = 258) | p value<sup>a</sup> | p value<sup>b</sup> |
|------------------------------|--------------|--------------|----------------------------------|-------------------|---------------------|---------------------|
| Success of procedure, n (%)  | 324 (95.3)   | 80 (97.6)    | 24 (92.3)                        | 244 (94.6)        | 0.27                | 0.63                |
| Number of clips, n           | 1.5 ± 0.7    | 1.4 ± 0.6    | 1.3 ± 0.6                        | 1.5 ± 0.7         | 0.15                | 0.09                |
| P<sub>mean</sub> after TMVR, mmHg | 3.7 ± 1.7   | 3.6 ± 1.6    | 3.7 ± 2.2                        | 3.8 ± 1.8         | 0.51                | 0.89                |
| Vascular complications, n (%)| 10 (2.9)     | 3 (3.7)      | 1 (3.8)                          | 7 (2.7)           | 0.66                | 0.74                |
| Intrahospital mortality, n (%)| 17 (5)       | 4 (4.9)      | 2 (7.7)                          | 13 (5)            | 0.95                | 0.56                |

**Note:** Values are presented as mean ± standard deviation or the number of patients (%).

**Abbreviations:** COPD, chronic obstructive pulmonary disease; P<sub>mean</sub>, mean transmitral pressure gradient; TMVR, transcatheter mitral valve repair.

<sup>a</sup>COPD versus non-COPD.

<sup>b</sup>Severe/very severe COPD vs. non-COPD.
Prevalence of COPD in patients undergoing TMVR

It is well established that heart failure and COPD coexist and share similar signs and symptoms. On the one hand, valvular heart disease (VHD) is frequently underdiagnosed among COPD patients, which worsens their quality of life and prognosis. On the other hand, it has been estimated that 20% of patients undergoing cardiac surgery including mitral valve surgery have COPD, which was associated with a worse prognosis. However, although the prevalence of COPD among TMVR candidates was previously estimated to be about 15%–24%, these estimates have not been confirmed using PFTs routinely in all TMVR candidates. In our study, the prevalence of COPD was 24% among TMVR, which was confirmed by preprocedural PFTs, an approach providing a more accurate estimation.

Outcome of TMVR in patients with COPD

COPD is associated with a worse prognosis in patients undergoing mitral valve surgery, which makes TMVR an attractive alternative to surgery in COPD patients. However, data describing the outcome of COPD patients undergoing TMVR is scarce and diverse. In post hoc analysis of the COAPT trial, the authors reported a higher rate of rehospitalization and an increase in the 2-years all-cause mortality among patients with COPD compared with those without COPD. However, in this analysis, patients were not routinely assessed for the presence of COPD using PFTs, which represents a significant limitation as COPD is frequently under- or over-diagnosed in patients with a known cardiac disease. For example, in our cohort, whole-body plethysmography did not confirm the presence of COPD in many patients who were previously reported to have COPD. Furthermore, COPD patients in the COAPT trial had significantly poorer outcomes compared to those without COPD.
more comorbidities such as coronary artery disease and peripheral artery disease, which may have also contributed to their worse outcome. In accordance, the association between COPD and unfavorable prognosis after TMVR in COAPT was not significant anymore after adjusting for confounding factors, and the benefit of TMVR compared with medical therapy in terms of rehospitalization for heart failure and symptoms was still evident in COPD patients. In a monocentric observational study, Schneider et al. investigated the implication of any pulmonary disease on the outcome of patients undergoing TMVR. According to their findings, similar reduction in the severity of MR as well as in dyspnea NYHA category were observed in patients with and without pulmonary disease, but with significantly increased all-cause mortality in patients with pulmonary disease. However, in that study and in contrast to ours, many patients who underwent TMVR were excluded due to missing PFT data. Furthermore, patients with obstructive lung disease represented only 24% of 156 patients with pulmonary disease enrolled in the study, which may have led to negative bias, regarding high mortality rates in patients with some restrictive lung diseases such as idiopathic pulmonary fibrosis. Despite some trend to an increased 1-year mortality among COPD patients in our cohort (30.8% vs. 20.2%), this high mortality rate was statistically not significantly different compared with patients not suffering from COPD ($p = 0.06$). This means that TMVR seems to be a safe procedure for COPD patients, considering the known high mortality among all TMVR candidates. In contrast to the post-hoc analysis of the COAPT trial, baseline characteristics in our cohort, did not differ between patients with and without COPD, which may also explain the comparable outcome in both groups as well. In accordance with our results, the presence of COPD was not associated with worse outcomes in two other large register studies in patients undergoing TMVR.

### 5.3 Severity of COPD and outcome after TMVR

It is well known that impaired pulmonary functions, especially lower values of forced expiratory volume in 1 s (FEV1) and vital capacity (VC), are associated with increased cardiovascular morbidity and mortality. To better evaluate the effect of COPD on TMVR outcomes, we investigated possible associations between the severity of COPD and PFT limitations with adverse outcomes after TMVR. However, the regression analysis did not show any significant association between GOLD stage or any other PFT variable with adverse outcomes after TMVR. Notably, no such analysis was described by the studies which reported an association between COPD and worse outcome after TMVR.

### 5.4 Limitations

Although this study adds further information to the knowledge about TMVR in patients with COPD, we acknowledge that it is mainly limited by its retrospective observational nature and the small sample size. Furthermore, this investigation suffers the usual shortcomings of a single-center study.

### 5.5 Conclusions

Patients with COPD represent a considerable proportion of those undergoing TMVR. Although mortality rates among COPD patients

| Table 5 Association between severity of COPD and PFT variables with outcome of TMVR in patients with COPD |
|-----------------------------------------------|
| **Correlation coefficient** | **p value** |
| **One-year rehospitalization** |
| Presence of COPD | 0.82 (0.47–1.44) | 0.50 |
| GOLD stage (per stage) | 0.98 (0.46–2.07) | 0.95 |
| FEV₁, % of predicted (per 10% reduction) | 1.08 (0.78–1.49) | 0.62 |
| VC, % of predicted (per 10% reduction) | 0.94 (0.69–1.27) | 0.68 |
| RV/TLC, % (per 10 points increase) | 1.00 (0.77–1.31) | 0.98 |
| Severity of TR | 1.14 (0.82–1.59) | 0.44 |
| **One-year mortality** |
| Presence of COPD | 1.72 (0.97–3.06) | 0.06 |
| GOLD stage (per stage) | 1.43 (0.69–2.99) | 0.34 |
| FEV₁, % of predicted (per 10% reduction) | 1.13 (0.82–1.55) | 0.45 |
| VC, % of predicted (per 10% reduction) | 1.04 (0.77–1.41) | 0.79 |
| RV/TLC, % (per 10 points increase) | 1.12 (0.86–1.47) | 0.38 |
| Severity of TR | 1.44 (0.98–2.11) | 0.062 |
| **Composite endpoint**a |
| Presence of COPD | 1.25 (0.74–2.09) | 0.39 |
| GOLD stage (per stage) | 1.37 (0.68–2.79) | 0.37 |
| FEV₁, % of predicted (per 10% reduction) | 1.16 (0.86–1.57) | 0.33 |
| VC, % of predicted (per 10% reduction) | 1.06 (0.80–1.41) | 0.68 |
| RV/TLC, % (per 10 points increase) | 1.13 (0.88–1.46) | 0.33 |
| Severity of TR | 1.34 (0.97–1.85) | 0.08 |

Abbreviations: COPD, chronic obstructive pulmonary disease; FEV₁, forced expiratory volume in 1 s; GOLD, global initiative for obstructive lung disease; PFT, pulmonary function test; RV/TLC, residual volume/total lung capacity; TMVR, transcatheter mitral valve repair; VC, vital capacity.

aComposite endpoint of death or hospitalization due to acute heart failure.
after TMVR are still high, TMVR seems to be safe and effective in patients with COPD and may be considered as a therapy option in those presenting with symptomatic severe MR. Therefore, impaired pulmonary functions alone should not prevent undertaking TMVR.

CONFLICTS OF INTEREST
The authors declare no conflicts of interest.

DATA AVAILABILITY STATEMENT
The data that support the findings of this study are available from the corresponding author upon reasonable request.

REFERENCES

1. Mannino DM. COPD: epidemiology, prevalence, morbidity and mortality, and disease heterogeneity. Chest. 2002;121(5 Suppl): 121s-126s.
2. Mensah GA, Roth GA, Fuster V. The global burden of cardiovascular diseases and risk factors: 2020 and beyond. J Am Coll Cardiol. 2019;74(20):2529-2532.
3. Hawkins NM, Petrie MC, Jhund PS, Chalmers GW, Dunn FG, McMurray JJ. Heart failure and chronic obstructive pulmonary disease: diagnostic pitfalls and epidemiology. Eur J Heart Fail. 2009;11(2):130-139.
4. Rabe KF, Hurst JR, Suissa S. Cardiovascular disease and COPD: dangerous liaisons? Eur Respir Rev. 2018;27:149.
5. Nkomo VT, Gardin JM, Skelton TN, Gottlieb JS, Scott CG, Enriquez-Sarano M. Burden of valvular heart diseases: a population-based study. Lancet. 2006;368(9540):1005-1011.
6. Rossi A, Dini FL, Faggiano P, et al. Independent prognostic value of functional mitral regurgitation in patients with heart failure. A quantitative analysis of 1256 patients with ischaemic and non-ischaemic dilated cardiomyopathy. Heart. 2011;97(20):1675-1680.
7. Nashef SA, Roques F, Sharples LD, et al. EuroSCORE II. Eur J Cardiothorac Surg. 2012;41(4):734-744, discussion 744-5.
8. de-Miguel-Diez J, López-de-Andrés A, Hernández-Barrera V, et al. Trends, characteristics, in-hospital outcomes and mortality in surgical mitral valve replacement among patients with and without COPD in Spain (2001-2015). PLoS One. 2019;14(8):e0221263.
9. Feldman T, Foster E, Glower DD, et al. Percutaneous repair or surgery for mitral regurgitation. N Engl J Med. 2011;364(15):1395-1406.
10. Stone GW, Lindenfeld J, Abraham WT, et al. Transcatheter mitral-valve repair in patients with heart failure. N Engl J Med. 2018;379(24):2307-2318.
11. Saxon JT, Cohen DJ, Chhatriwalla AK, et al. Impact of COPD on outcomes after mitraClip for secondary mitral regurgitation: the COAPT trial. JACC Cardiovasc Interv. 2020;13(23):2795-2803.
12. Soriano JB, Zielinski J, Price D. Screening for and early detection of chronic obstructive pulmonary disease. Lancet. 2009;374(9691): 721-732.
13. Daniellsön P, Öljeforsdottr IS, Benediktsdóttir B, Gíslason T, Janson C. The prevalence of chronic obstructive pulmonary disease in Uppsala, Sweden—the Burden of Obstructive Lung Disease (BOLD) study: cross-sectional population-based study. Clin Respir J. 2012;6(2): 120-127.
14. Bolton CE, Ionescu AA, Edwards PH, Faulkner TA, Edwards SM, Shale DJ. Attaining a correct diagnosis of COPD in general practice. Respir Med. 2005;99(4):493-500.
15. Walker PP, Mitchell P, Diamantea F, Warburton CJ, Davies L. Effect of primary-care spirometry on the diagnosis and management of COPD. Eur Respir J. 2006;28(5):945-952.
16. Arne M, Lisspers K, Stålberg B, et al. How often is diagnosis of COPD confirmed with spirometry? Respir Med. 2010;104(4): 550-556.
17. Lancellotti P, Tribouilloy C, Hagendorff A, et al. Recommendations for the echocardiographic assessment of native valvar regurgitation: an executive summary from the European Association of Cardiovascular Imaging. Eur Heart J Cardiovasc Imaging. 2013;14(7): 611-644.
18. Gössl M, Soraja P. MitraClip patient selection: inclusion and exclusion criteria for optimal outcomes. Ann Cardiothorac Surg. 2018;7(6):771-775.
19. Wanger J, Clausen JL, Coates A, et al. Standardisation of the measurement of lung volumes. Eur Respir J. 2005;26(3):511-522.
20. Miller MR, Hankinson J, Brusasco V, et al. Standardisation of spirometry. Eur Respir J. 2005;26(2):319-338.
21. Matthys H, Sorichter S. Lungenfunktionuntsuchungenin: Matthys H, Seeger W, eds. Klinische Pneumologie. Vol 2. Springer Medizin Verlag; 2008:56-78.
22. Global Initiative for Chronic Obstructive Lung Disease (GOLD). Global Strategy for the Diagnosis, Management and Prevention of Chronic Obstructive Pulmonary Disease (Report). 2021. www.goldcopd.org. Accessed December 18, 2021. https://goldcopd.org/wp-content/uploads/2020/11/GOLD-REPORT-2021-v1.1-25Nov20_WMV.pdf
23. Sherif MA, Paranskaya L, Yuecel S, et al. MitraClip step by step; how to simplify the procedure. Neth Heart J. 2017;25(2):125-130.
24. Freixa X, Portillo K, Paré C, et al. Echocardiographic abnormalities in patients with COPD at their first hospital admission. Eur Respir J. 2013;41(4):784-791.
25. McKeon NJ, Timmins SN, Stewart H, Yerkovich ST, McKeon JL. Diagnosis of COPD before cardiac surgery. Eur Respir J. 2015;46(5): 1498-1500.
26. Zueren CS, Bauer A, Lubos E, et al. Influence of non-cardiac comorbidities on outcome after percutaneous mitral valve repair: results from the German transcatheter mitral valve interventions (TRAMI) registry. Clin Res Cardiol. 2015;104(12):1044-1053.
27. Schneider LM, Nicolaeta N, Schepperne N, et al. Implications of concomitant obstructive or restrictive pulmonary diseases on functional and clinical results after MitraClip. Catheter Cardiovasc Interv. 2021;98:1000.
28. Nathan SD, Shlobin OA, Weir N, et al. Long-term course and prognosis of idiopathic pulmonary fibrosis in the new millennium. Chest. 2011;140(1):221-229.
29. Kortlandt F, Velu J, Schurer R, et al. Survival after mitraClip treatment compared to surgical and conservative treatment for high-surgical-risk patients with mitral regurgitation. Circ Cardiovasc Interv. 2018;11(6):e005985.
30. Puls M, Lubos E, Boekstegers P, et al. One-year outcomes and predictors of mortality after MitraClip therapy in contemporary clinical practice: results from the German transcatheter mitral valve interventions registry. Eur Heart J. 2016;37(8):703-712.
31. Nickenig G, Estevez-Loureiro R, Franzen O, et al. Percutaneous mitral valve edge-to-edge repair: in-hospital results and 1-year follow-up of 628 patients of the 2011-2012 Pilot European Sentinel Registry. J Am Coll Cardiol. 2014;64(9):875-884.
32. Sin DD, Man SF. Chronic obstructive pulmonary disease as a risk factor for cardiovascular morbidity and mortality. *Proc Am Thorac Soc*. 2005;2(1):8-11.

33. Daher A, Dreher M. The bidirectional relationship between chronic obstructive pulmonary disease and coronary artery disease. *Herz*. 2020;45(2):110-117.

34. Scarlata S, Pedone C, Fimognari FL, Bellia V, Forastiere F, Incalzi RA. Restrictive pulmonary dysfunction at spirometry and mortality in the elderly. *Respir Med*. 2008;102(9):1349-1354.

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