

# The prevalence, aetiologies, and clinical consequences of tricuspid regurgitation associated with severe degenerative mitral regurgitation

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## Aims

The prevalence, the aetiologies, and the clinical features of tricuspid regurgitation (TR) in the context of concomitant degenerative mitral valve (MV) disease are poorly defined. This paper aims to assess the prevalence, determinants, and clinical consequences of TR in severe degenerative mitral regurgitation (DMR)

## Methods and results

Clinical and echocardiographic characteristics were collected among patients with severe DMR. A total of 884 patients were included in our study, 31% with  $\geq$  moderate TR. Tricuspid valve prolapse (TVP) was the most common aetiology (487 patients, 55%), followed by atrial functional TR (AFTR, 172 patients, 19%) and ventricular functional TR (VFTR, 42 patients, 5%), while TR aetiology was classified as mixed in 183 (21%) patients. Patients with TVP were younger and had a better clinical presentation, few comorbidities, and less haemodynamically relevant TR. Patients with VFTR were characterized by older age, worse clinical presentation, and both highest comorbidity rate and prevalence of >mild TR. Patients with AFTR showed an intermediate profile of clinical presentation and comorbidities and the largest tricuspid annulus (TA) diameter. MV surgery was performed in 785 (88%) patients; 132 (15%) underwent simultaneous TV intervention, more often patients with AFTR (32%). TA dilatation [odds ratio (OR) 3.68, 95% confidence interval (CI) 2.05–6.62,  $P < 0.001$ ] and >mild TR (OR 9.30, 95% CI 5.10–16.95,  $P < 0.001$ ) were independently associated with TV intervention.

## Conclusion

In patients with severe DMR, TR presents with different aetiologies, clinical features, and echocardiographic phenotypes that require a comprehensive assessment at the time of DMR surgery to ensure the best management for these patients.

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**Table 1** Baseline clinical characteristics of the overall population and of patients according to TR aetiology

	Overall population (n = 884)	Organic TR (n = 487, 55%)	Ventricular functional TR (n = 42, 5%)	Atrial functional TR (n = 172, 19%)	Mixed aetiology (n = 183, 21%)	Overall P-value	P-value (organic vs. ventricular functional TR)	P-value (organic vs. atrial functional TR)
Age (years)	63.2 ± 14.1	62.5 ± 13.8	75.2 ± 9.5	69.0 ± 13.0	57 ± 13.3	<0.001	<0.001	<0.001
Female gender, n (%)	302 (34%)	193 (39%)	8 (19%)	54 (31%)	47 (26%)	<0.001	0.013	0.068
Weight (kg)	70.4 ± 13.2	68.6 ± 13.2	74.1 ± 14.4	71.5 ± 13.3	73 ± 12.1	<0.001	0.024	0.062
BMI (kg/m <sup>2</sup> )	24.1 ± 3.6	23.6 ± 3.5	25.2 ± 3.9	24.4 ± 3.4	24.5 ± 3.7	0.008	0.036	0.068
BSA (m <sup>2</sup> )	1.8 ± 0.2	1.79 ± 0.2	1.85 ± 0.2	1.83 ± 0.2	1.86 ± 0.2	<0.001	0.066	0.205
Hypertension	373 (42%)	198 (40%)	23 (55%)	88 (51%)	64 (35%)	<0.001	0.013	0.021
Diabetes	33 (4%)	18 (4%)	4 (9%)	4 (2.5%)	7 (4%)	0.367	0.366	0.536
Dyslipidaemia	170 (19%)	86 (18%)	14 (33%)	39 (22%)	31 (17%)	0.010	0.004	0.182
Smoking history (former or current)	275 (31%)	150 (31%)	11 (27%)	54 (31%)	60 (33%)	0.824	0.504	0.637
History of CAD	84 (10%)	37 (7%)	9 (21%)	19 (11%)	19 (10%)	0.027	0.010	0.220
Previous CABG	10 (1%)	4 (0.8%)	2 (5%)	3 (2%)	1 (0.5%)	0.067	0.094	0.560
Peripheral vascular artery disease	50 (5%)	27 (6%)	4 (10%)	11 (6%)	8 (4%)	0.079	0.309	0.853
Previous AV intervention	8 (0.9%)	4 (0.8%)	1 (2.5%)	3 (2%)	0 (0%)	0.236	0.811	0.561
History of dilated cardiomyopathy	11 (1%)	3 (0.6%)	2 (4%)	5 (3%)	1 (0.5%)	0.065	0.162	0.053
Previous ischaemic stroke/TIA	15 (2%)	9 (2%)	0 (0%)	3 (2%)	3 (2%)	0.568	0.866	0.944
Previous haemorrhagic stroke	3 (0.3%)	1 (0.2%)	0 (0%)	1 (0.6%)	1 (0.5%)	0.699	0.784	0.442
Previous PM implantation	22 (2.5%)	6 (1%)	8 (20%)	4 (2.5%)	4 (2%)	<0.001	<0.001	0.518
Previous ICD or CRT implantation	12 (1.5%)	4 (0.8%)	4 (9%)	2 (1%)	2 (1%)	0.003	0.003	0.695
Atrial fibrillation	173 (20%)	75 (15%)	12 (28%)	59 (35%)	27 (15%)	<0.001	0.014	<0.001
Permanent AF	55 (6%)	18 (4%)	7 (16%)	24 (14%)	6 (3%)	<0.001	<0.001	<0.001
Paroxysmal or persistent AF	118 (13%)	57 (12%)	5 (12%)	35 (20%)	21 (11%)	<0.001	0.842	0.003
COPD	38 (4%)	15 (3%)	4 (10%)	8 (5%)	11 (6%)	0.117	0.05	0.480
History of cancer (past or active)	79 (9%)	39 (8%)	3 (7%)	16 (9%)	21 (11%)	0.633	0.925	0.230
CKD	120 (14%)	65 (13%)	10 (24%)	38 (22%)	7 (4%)	<0.001	0.041	0.184
eGFR (CKD-EPI, mL/min/m <sup>2</sup> )	81 ± 22.4	81.6 ± 22.6	66.1 ± 19.2	74.5 ± 22.7	89 ± 18.3	<0.001	<0.001	0.007
AST (μ/L)	30 ± 69.8	26.5 ± 15.1	82.6 ± 31.1	26.8 ± 11.2	31.1 ± 40	0.102	0.136	0.362
ALT (μ/L)	28.1 ± 49	25.5 ± 20.5	47.3 ± 132	24.8 ± 14.2	34.8 ± 82.2	0.236	0.569	0.926
GGT (μ/L)	29 ± 27.6	27.2 ± 25.9	32.9 ± 18.8	33.6 ± 33.4	28.3 ± 22.1	0.020	0.034	0.011
Total bilirubin (mg/dL)	0.82 ± 0.66	0.78 ± 0.66	1.04 ± 0.67	0.84 ± 0.67	0.87 ± 1.22	0.007	0.003	0.119
Liver congestion	34 (4%)	17 (3%)	2 (5%)	7 (4%)	8 (4%)	0.669	0.714	0.858
Anaemia	178 (20%)	69 (14%)	14 (33%)	39 (22%)	56 (30%)	<0.001	<0.001	0.013
Peripheral oedema	52 (6%)	20 (4%)	10 (23%)	14 (8%)	8 (4%)	0.006	0.002	0.137
Charlson comorbidity index	2.8 ± 2.0	2.7 ± 2.0	4.3 ± 2.0	3.5 ± 2.1	1.98 ± 1.7	<0.001	<0.001	<0.001

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**Table 2** Echocardiographic characteristics of the overall population and of patients according to TR aetiology

	Overall (n = 884)	Organic TR (n = 487, 55%)	Ventricular functional TR (n = 42, 5%)	Atrial functional TR (n = 172, 19%)	Mixed aetiology (n = 183, 21%)	Overall P-value	P-value(organic vs. ventricular functional TR)	P-value (organic vs. atrial functional TR)
MV disease						<0.001	<0.001	0.056
Single-leaflet prolapse	245 (28%)	118 (24%)	26 (62%)	55 (32%)	46 (25%)			
Bileaflet prolapse	639 (72%)	369 (76%)	16 (38%)	117 (68%)	137 (74%)			
Myxomatous degeneration	589 (66%)	331 (68%)	7 (17%)	96 (56%)	126 (69%)	<0.001	<0.001	<0.001
Fibroelastic deficiency	295 (34%)	134 (27%)	27 (64%)	68 (39%)	50 (27%)	<0.001	<0.001	<0.001
MR EROA PISA (cm <sup>2</sup> )	0.6 ± 0.2	0.56 ± 0.23	0.52 ± 0.8	0.57 ± 0.23	0.52 ± 0.18	0.383	0.567	0.837
MR VC 3D (cm <sup>2</sup> )	0.70 ± 0.3	0.70 ± 0.30	0.85 ± 0.44	0.72 ± 0.28	0.69 ± 0.28	0.519	0.238	0.641
LV-EDV (mL)	137.3 ± 40.7	134 ± 39.6	162 ± 64.6	138 ± 37.7	139 ± 40.5	0.051	0.020	0.237
Indexed LV-EDV (mL/m <sup>2</sup> )	75.4 ± 19.5	74.4 ± 18.7	83.9 ± 30.9	76.1 ± 17.7	74.9 ± 19.3	0.335	0.183	0.254
LVEF (%)	62 ± 6.3	63 ± 5.8	57 ± 8.8	61 ± 7.1	62 ± 5.2	<0.001	<0.001	0.007
LV GLS (%)	-21.9%±4	-22.2 ± 3	-17.2 ± 3	-21.8 ± 4	-22.2 ± 3	0.001	<0.001	0.670
LAESV (mL)	93.2 ± 41.1	90.8 ± 34.9	154 ± 90.7	105 ± 41.3	78.3 ± 28.5	<0.001	<0.001	0.007
Indexed LAESV (mL/m <sup>2</sup> )	51.5 ± 22.2	50.6 ± 18.6	74.1 ± 52.2	58.1 ± 22.0	43 ± 14.2	<0.001	0.001	0.002
Enlarged LA	723 (88%)	409 (84%)	35 (83%)	152 (89%)	127 (69%)	<0.001	0.638	0.020
Aortic stenosis						<0.001	<0.001	0.039
None	845 (96%)	471 (96.8%)	34 (80%)	162 (94%)	178 (97%)			
Mild	28 (3%)	15 (3%)	4 (10%)	6 (4%)	3 (2%)			
Moderate	11 (1%)	1 (0.2%)	4 (10%)	4 (2%)	4 (2%)			
Aortic regurgitation						<0.001	<0.001	0.033
None	609 (69%)	341 (70%)	18 (43%)	104 (60%)	146 (79%)			
Mild	237 (27%)	131 (27%)	16 (38%)	56 (33%)	34 (19%)			
Moderate	38 (4%)	15 (3%)	8 (19%)	12 (7%)	3 (2%)			
PASP (mmHg)	35 ± 12	33 ± 12	55 ± 12	40 ± 12	28 ± 6	<0.001	<0.001	<0.001
PASP > 50 mmHg	97 (11%)	35 (7%)	26 (62%)	28 (16%)	8 (4%)	<0.001	<0.001	<0.001
RV basal EDD (mm)	37.4 ± 5.7	35.8 ± 4	43.4 ± 7	40.2 ± 6	35.2 ± 3.5	<0.001	<0.001	<0.001
RV mid EDD (mm)	28.6 ± 5.1	27.7 ± 4	33.8 ± 8	29.9 ± 5	27.2 ± 5	<0.001	<0.001	<0.001
Dilated RV	126 (14%)	42 (8%)	19 (45%)	54 (31%)	11 (6%)	<0.001	<0.001	<0.001
TAPSE	23 ± 4.3	24 ± 4	19 ± 4	23 ± 4	24 ± 4	<0.001	<0.001	0.013
S' TDI	13.2 ± 3	13.2 ± 2	12.9 ± 8	13.4 ± 2	13.5 ± 2	<0.001	<0.001	0.988
FAC* (%)	43 ± 5	44 ± 5	36 ± 8	43 ± 6	44 ± 4	<0.001	<0.001	0.624
RV dysfunction	41 (5%)	11 (2%)	17 (40%)	10 (6%)	3 (2%)	<0.001	<0.001	0.022
TA end-diastolic diameter (mm)	36.3 ± 6	34.4 ± 5	40.1 ± 6	40.8 ± 4	32.3 ± 4	<0.001	<0.001	<0.001
TA end-diastolic indexed diameter (mm/m <sup>2</sup> )	20.3 ± 3	19.4 ± 3	21.5 ± 3	22.4 ± 2	17.5 ± 3	<0.001	0.001	<0.001
Dilated tricuspid annulus	323 (36%)	149 (31%)	21 (50%)	144 (84%)	9 (5%)	<0.001	0.016	<0.001
Tricuspid regurgitation						<0.001	<0.001	<0.001

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