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## Clinical Significance of Right Ventricular Longitudinal Function Parameters After Aortic Valve Replacement



Changes in parameters of longitudinal systolic function after cardiac surgery (i.e., tricuspid annular plane systolic excursion [TAPSE] and peak systolic velocity [PSV] of tricuspid annulus obtained by M-mode or Doppler tissue imaging) have been described for many years, with almost no data on their clinical significance (1,2). We aimed at investigating, in a large prospective cohort, the natural course and long-term clinical significance of early alterations in right ventricular (RV) longitudinal function after aortic valve replacement (AVR) for aortic stenosis. We hypothesized that long-term prognosis after AVR would be the worst in patients with the lowest post-operative RV longitudinal function.

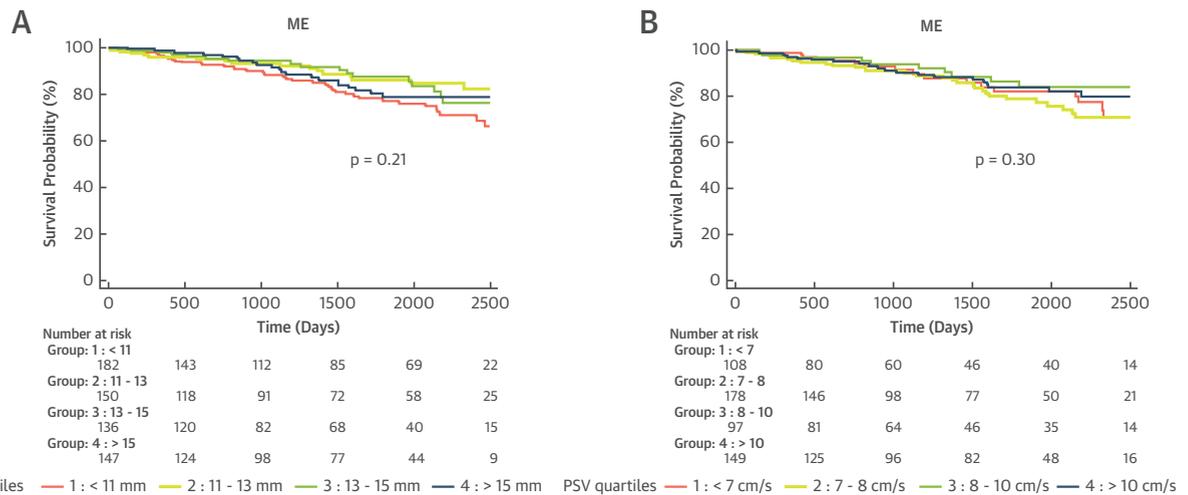
Between January 2009 and December 2015, we prospectively explored all consecutive patients referred to our heart valve clinic for AVR who presented with severe aortic stenosis, normal left ventricular ejection fraction (>50%), and TAPSE (>14 mm). Patients with another significant valvular disease, a medical history of previous cardiac surgery,

or congenital heart diseases were excluded. TAPSE and PSV were assessed by transthoracic echocardiography 7 days after cardiac surgical procedures for all patients and 1 year after AVR in a subgroup of 100 patients. Patients were followed for major events (ME), defined as cardiovascular death, cardiac hospitalization, acute heart failure, and stroke. Events were adjudicated by 2 independent blinded investigators. The local ethics committee approved the protocol, and patients gave informed consent.

We hypothesized a rate of ME at 5 years of 15% in the quartile of patients with the highest post-operative TAPSE and a rate of 30% in the quartile of patients with the lowest post-operative TAPSE (3,4). This hypothesis implied that we had to analyze outcomes in at least 544 patients (i.e., 136 per quartile) to obtain a statistical power of 90% and a probability of a type I error of 0.05. Continuous variables were given as mean  $\pm$  SD. One-way analysis of variance was used for repeated measure with the Bonferroni post hoc paired Student's *t* test. Time-related clinical events were plotted with Kaplan-Meier curves according to quartiles of RV function parameters and were compared with log-rank tests for trend. A value of  $p < 0.05$  was considered statistically significant. Statistics were performed using MedCalc software version 16.4 (MedCalc, Ostend, Belgium).

Among 805 consecutive patients referred for first AVR, 617 patients were included and followed for prognosis. In these patients, the mean age was  $71 \pm 10$  years. The population was 54% male, and one-third of the participants had diabetes. One-third underwent concomitant coronary artery bypass graft operation, and 80% received a biological prosthesis. As expected, TAPSE and PSV were both clearly decreased 7 days post-operatively ( $13.5 \pm 3.8$  mm vs.  $22.1 \pm 4.6$  mm at baseline;  $p < 0.0001$ ; and  $8.4 \pm 2.3$  cm/s vs.  $11.9 \pm 3.0$  cm/s at baseline;  $p < 0.0001$ , respectively), with an incomplete but significant recovery to pre-operative values 1 year after AVR in the subgroup with serial transthoracic echocardiography ( $p < 0.0001$  for both). In these patients, who did not differ significantly from the entry population (data not shown), TAPSE was  $23.5 \pm 4.0$ ,  $13.0 \pm 3.1$ , and  $18.4 \pm 3.5$  mm, and PSV was  $12.9 \pm 3.0$ ,  $7.7 \pm 2.0$ , and  $9.5 \pm 2.0$  cm/s, respectively before, 7 days after, and 1 year after AVR.

The mean post-operative follow-up was  $4.0 \pm 2.3$  years (median 4 years; range 1.9 to 6.1 years) for the 617 patients. ME occurred in 95 patients (15.5%), with 33 cardiovascular deaths, 71 cardiac hospitalizations, 36 cases of acute heart failure, and 38 strokes. No association was found between post-operative TAPSE values and ME occurrence as a whole (Figure 1A) or taken individually (data not shown).

**FIGURE 1 Kaplan-Meier Survival Curves of the Long-Term Prognostic Impact of Post-Operative RV Function**

Event-free survival according to (A) tricuspid annular plane systolic excursion (TAPSE) quartiles and (B) peak systolic velocity (PSV) quartiles. p value by log-rank test for trend. ME = major event(s); RV = right ventricular.

The absence of association with ME remained even after correcting TAPSE by systolic pulmonary artery pressure ( $p = 0.24$ ). Along the same line, neither PSV at discharge ( $p = 0.30$ ) nor the PSV/systolic pulmonary artery pressure ratio ( $p = 0.22$ ) predicted long-term onset of ME (Figure 1B).

In our mind, the lack of prognostic insight of post-operative TAPSE and PSV after AVR suggests that: 1) the magnitude of RV longitudinal function recovery in the months following AVR can be sufficient to prevent clinical RV failure; or 2) changes in RV geometry secondary to pericardial opening make post-operative TAPSE and PSV faulty (1). Further studies are required to test these 2 hypotheses, as well as to ascertain whether other parameters of post-operative RV function are associated with long-term outcomes after AVR.

To conclude, the early and severe post-operative decline in RV longitudinal function reverses within a year and is not predictive of long-term outcomes after AVR.

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