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Physiologic correlates of tricuspid annular plane systolic excursion in 1168 healthy subjects

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ABSTRACT

Background: TAPSE provides a simple, reproducible estimate of the longitudinal function of the right ventricle (RV). However, the normal limits and physiologic correlates of tricuspid annular plane systolic excursion (TAPSE) are not exactly known. The aim of this study was to explore the full spectrum of TAPSE values and determine the physiologic correlates of TAPSE.

Methods and results: From June 2007 to December 2013, 1168 healthy subjects [mean age 45.1 ± 16 years, range 16 to 92; 555 (47.5%) men] underwent comprehensive transthoracic echocardiography (TTE) as recommended by current guidelines. TAPSE values were higher in men than women (24.0 ± 3.5 vs 23.2 ± 3.0 mm, p value < 0.0001) but did not vary according to age. On multivariable linear regression analysis, cardiac output, RV basal and longitudinal dimensions were the only variables independently associated with TAPSE (β coefficient = 0.161, 0.116 and 0.115 respectively). On the other hand echocardiographically-derived systolic pulmonary artery pressure (SPAP), pulmonary vascular resistance and mitral E/e′ ratio were significantly higher in older subjects. Therefore a significant decrease of TAPSE/SPAP was detected in >60 years old cohort ($p = 0.0001$).

Conclusions: Our large cohort of healthy subjects provides sex and age-based TAPSE and TAPSE/SPAP normal cut-offs. TAPSE was found to be higher in men but not influenced by age. It was mainly correlated with echo-Doppler indices reflecting pre-load as opposed to afterload. On the other hand a significant decrease of TAPSE/SPAP with older age was registered as a direct consequence of increased SPAP with aging.

1. Introduction

Right ventricular (RV) function has been shown to be a major determinant of clinical outcome in pulmonary hypertension (PH). [1] There are many methods available for estimating RV systolic function by transthoracic echocardiography (TTE), though all have limitations. [2–5] Tricuspid annular plane systolic excursion (TAPSE) is a simple and reproducible method that evaluates the longitudinal motion of the RV base — a key component in RV ejection. A TAPSE value of <17 mm as assessed by TTE has been demonstrated to be a strong prognostic index. [6–11] However, the normal limits of TAPSE are not exactly known. [2,3].

Abbreviations: AT, acceleration time; BP, blood pressures; BSA, body surface area; BMI, body mass index; CO, cardiac output; EF, ejection fraction; HR, heart rate; IVC, inferior vena cava; LAVI, left atrial volume indexed to BSA; LV, left ventricle; SPAP, systolic pulmonary artery pressure; PH, pulmonary hypertension; PVR, pulmonary vascular resistance; RA, right atrium; RAP, right atrial pressure; RV, right ventricle; RVOT, right ventricular outflow tract; RVSP, right ventricular systolic pressure; SV, stroke volume; TAPSE, tricuspid annular plane systolic excursion; TDI, tissue Doppler imaging; TTE, transthoracic echocardiography; TRV, tricuspid regurgitation velocity; VTI, velocity time integral.

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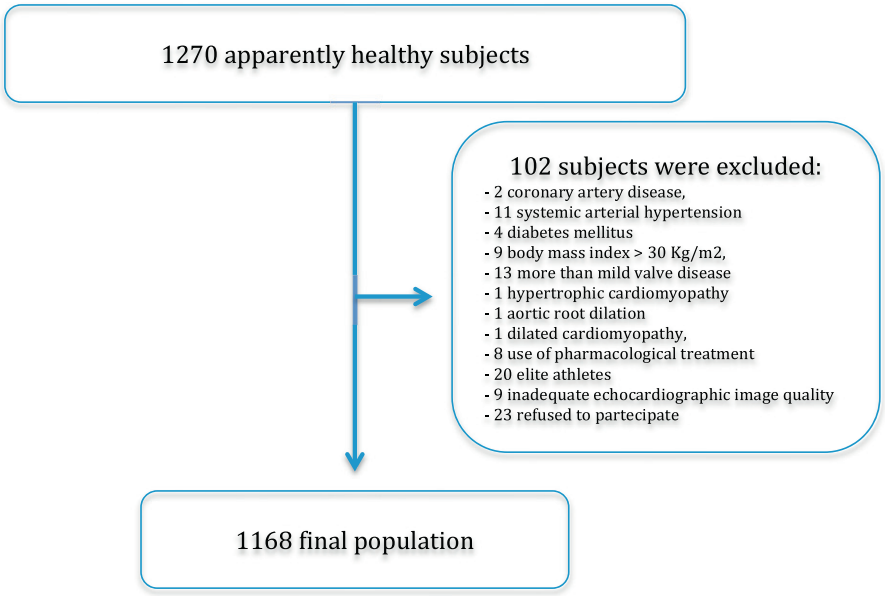

Fig. 1. Patient selection.

Therefore, the aim of this study was to explore the full range of TAPSE values in a large cohort of healthy subjects, and to investigate its relationship to clinical and echocardiographic correlates.

2. Methods

From June 2007 to February 2014, a sample of 1270 consecutive apparently healthy adults were referred to the echocardiographic laboratories of the Cardiology Division, "Cava de'Tirreni-Amalfi Coast", Heart Department, University Hospital of Salerno, Italy and the Department of Cardiology and Emergency Medicine of San Antonio Hospital, San Daniele del Friuli, Udine, Italy for the purpose of the present study and as already described elsewhere. [12,13] Healthy volunteers (or subjects for work ability assessment) underwent full screening for cardiovascular disease including a questionnaire on medical history, use of medications, cardiovascular risk factors and lifestyle habits (alcohol intake, smoking, physical activity). Physical examinations [height, weight, heart rate (HR) and blood pressure (BP)] and clinical assessments were conducted according to standardized protocols by trained and certified staff. Body surface area (BSA) was calculated according to the DuBois formula [0.20247 × height (m) 0.725 × weight (kg) 0.425]. Three BP measurements were obtained from the right arm by sphygmomanometry and the results were averaged to determine systolic and diastolic BP.

Exclusion criteria were: coronary artery disease, systemic arterial hypertension, diabetes mellitus, significant (at least moderate) valvular heart disease, congenital heart disease, congestive heart failure, cardiomyopathies, sinus tachycardia, atrial fibrillation or flutter, use of illicit drugs, elite athletes and inadequate echocardiographic image quality. In addition, 23 of the initial subjects investigated refused to be included in the echocardiographic protocol. According to these criteria 102 out of 1270 subjects were excluded (Fig. 1). The final study population therefore consisted of 1168 healthy subjects [mean age 45.1 ± 16 years, range 16 to 92; 555 (47.5%) men] (Table 1). The study was approved by the institution's ethics board and informed consent was obtained from the participants.

2.1. Echocardiography

TTE examinations were performed with commercially available equipment on all subjects (Aloka α10 — Aloka, Tokyo, Japan; Vivid 7 — GE Healthcare, Milwaukee, USA). Specific views included the parasternal long- and short-axis views, apical 4, 2

Table 1
Demographic and clinical characteristics of study population.

Variable	Overall population 1168 patients (mean ± SD) (Median)	Range	Women 613 (52.5%) (mean ± SD)	*p* Value	Men 555 (47.5%) (mean ± SD)
Age (years)	45.4 ± 15.6 46	16–92	46.2 ± 15.4	0.075	44.6 ± 15.8
Height (cm)	168.6 ± 9.5 168	144–198	162.4 ± 6.7	**0.0001**	175.5 ± 7.1
Weight (kg)	69.7 ± 12.0 70	41–113	62.7 ± 8.8	**0.0001**	77.3 ± 10.4
BMI (kg/m^2)	24.4 ± 3.1 24.2	24.2–32.8	23.8 ± 3.24	**0.0001**	25.1 ± 2.8
BSA (m^2)	1.79 ± 0.19 1.78	1.06–2.76	1.67 ± 0.14	**0.0001**	1.92 ± 0.16
Systolic BP (mm Hg)	123.9 ± 12.1 125	84–145	121.8 ± 12.7	**0.0001**	126.1 ± 10.9
Diastolic BP (mm Hg)	76.1 ± 8.5 78.5	44–91	75.0 ± 8.4	**0.0001**	77.2 ± 8.3
Mean BP (mm Hg)	92.0 ± 8.7 93.3	57.3–110.6	90.6 ± 8.9	**0.0001**	93.5 ± 8.1
Pulse pressure (mm Hg)	47.7 ± 9.7 48	20–80	46.8 ± 9.6	**0.001**	48.8 ± 9.7
HR (b/m)	71.1 ± 11.6 70	45–105	73.3 ± 10.8	**0.025**	68.7 ± 11.9

HR, heart rate; BSA, body surface area; BMI, body mass index; BP, blood pressure;
p values indicate sex-related differences.
Bold data indicates P-value less than 0.05 statistically significant.