International Journal of Cardiology 284 (2019) 63–64

Contents lists available at ScienceDirect

International Journal of Cardiology

journal homepage: www.elsevier.com/locate/ijcard

Editorial

Measure the right parameters, set the right targets

Luigi P. Badano *, Giuseppe Sammarco, Denisa Muraru

Department of Cardiac, Thoracic, Vascular Sciences and Public Healthcare, University of Padua School of Medicine, Padova, Italy

ARTICLE INFO

Article history:
Received 30 September 2018
Accepted 10 October 2018
Available online 14 October 2018

In the last decade, there has been a concerted effort to use novel echocardiographic techniques (i.e. three-dimensional echocardiography -3DE, and myocardial deformation imaging) to assess the prognostic value of right ventricular (RV) function in different cardiac conditions [1]. Despite several clinical studies, there has been a significant lag time in harnessing this information to address patient management, partly due to: *i.* important limitations of conventional two-dimensional (2D) echocardiography to study the RV; *ii.* lack of normative data and, consequently, lack of thresholds to define clinically significant RV dysfunction using the new echocardiography techniques; and *iii.* a paucity of data regarding the incremental value of RV function over left ventricular (LV) function. Finally, it remains to be clarified whether RV dysfunction represents a predicable consequence of severe left heart diseases or rather a distinct entity that can be treated using established or novel therapies.

In their study, Magunia and coworkers [2], evaluated the usefulness of 3DE to predict the occurrence of RV failure and long-term outcome in patients undergoing continuous-flow LV assist device (LVAD) implantation. RV ejection fraction (EF) and free-wall longitudinal strain (FWLS) were obtained from transesophageal 3DE datasets acquired prior to implantation. Incidence of RV failure was 19.2%. The main findings were: *i.* conventional echocardiographic parameters of RV function, such as TAPSE, failed to be significant predictors of RV failure after LVAD; *ii.* both RVFWLS and RVEF (optimal cut-off values >10.1% and <25%, respectively) showed excellent discriminative value to identify patients at risk of RV failure after LVAD; *iii.* better long term survival was expected in patients with RVFWLS <−11.9%. Despite this study is retrospective and enrolled a limited number of patients, it adds significantly to current literature since: *i.* it confirms the usefulness of 3DE RVEF to predict occurrence of RV failure in LVAD recipients [3]; *ii.* it is the first to integrate parameters of both chamber (i.e. volumes and EF, which are load dependent) and myocardial function (i.e. strain, relatively load independent) derived from the same 3DE data set to assess patient prognosis. They showed that severely impaired RVEF and RVFWLS can both predict RV failure after LVAD, but only RVFWLS predicted long-term survival. Their findings need confirmation in larger prospective studies, but this study opens the way to the difficult task to reduce the incidence of RV failure after LVAD implantation.

Although there has been a steady progression from using M-mode, Doppler longitudinal indices and 2D fractional area change to myocardial deformation imaging by 2D speckle-tracking echocardiography to assess RV function, there is still paucity of outcome studies using 3DE. Since the RV has a peculiar crescentic morphology that cannot be assimilated to any known geometrical figures (thus preventing any possible calculation of its volumes from simple linear or area measurements), and distinct inflow and outflow regions that cannot be visualized in the same tomographic view, 3DE is particularly suited to measure RV volumes [1]. Cardiac magnetic resonance (CMR) remains the reference technique to assess RV function and myocardial tissue characteristics, and computerized tomography is growing in this area too. However, feasibility, portability at bedside or in the operating room, cost and repeatability considerations make 3DE the first line technique to measure RV volumes and EF in patients with adequate acoustic window [4].

Using novel software packages that allow a semiautomatic tracing of RV endocardial borders (like the one used by Magunia et al. [2]), feasibility, accuracy and reproducibility of RV volumes obtained by 3DE have largely increased [5] and reference values to define normal or abnormal RV size and function are available [6]. Moreover, we have a large number of studies comparing 3DE with CMR measurements, confirming slight underestimation of RV volumes by 3DE but very good agreement between RVEFs measured with the two modalities [7]. However, the clinical value of any imaging modality does not stand in how it compares with others, but in how it may affect patient management and prognosis. In this regard, evidence about the prognostic power of RV volumes and, particularly, RVEF obtained with 3DE is accumulating not only in selected cohorts of patients [3], but also in the general population [8].

In patients with significant RV overload (i.e. severe tricuspid regurgitation or pulmonary hypertension), the prognostic and clinical significance of RVEF is difficult to assess. In these conditions, RVFWLS (which is less dependent on loading conditions than EF) may add valuable clinical and prognostic data, stratify the prognosis and address

* Corresponding author at: Department of Cardiac, Thoracic, Vascular Sciences and Public Healthcare, University of Padua School of Medicine, Via Giustiniani 2, 35128 Padova, Italy.
E-mail address: lpbadano@gmail.com (L.P. Badano).

https://doi.org/10.1016/j.ijcard.2018.10.043
0167-5273/

management in patients with pulmonary arterial hypertension, pulmonary embolism, acute coronary syndromes, LV failure, arrhythmogenic cardiomyopathy and congenital heart diseases [1]. Reference values for RV FWLS are available [4,9]. However, the main problem of RVFWLS remains the selection of the correct apical RV focused view to use to perform measurements. Recently, the EACVI/ASE/Industry Task Force published a consensus document to standardize the acquisition, the way to measure RV strain, and the parameters to report [10]. However, small rotations of the probe can significantly change the orientation of the RV focused view in the crescentic perimeter of the RV (and consequently strain values), and there is no anatomical landmark available to check that two views taken at different time points during patient follow-up are really comparable. Therefore, the approach proposed by Magunia et al. [2] is particularly interesting. Deriving the 2D view by slicing the same 3DE dataset from which the RVEF has been obtained allows to control the spatial position of the cut plane and provides comparable 2D views each time we measure RVFWLS.

Overall, the work by Magunia et al. [2] highlights the potential value of 3DE to select candidates for LVAD implantation. Measurement of RVEF in routine clinical practice will increase, as access to and experience with 3DE are growing. The advent of artificial intelligence-based contouring algorithms will provide more rapid, accurate, and reproducible RVEF measurements and enhance work flow in echocardiography laboratories. As 3DE becomes more commonly used, studies that examine how RVEF can predict patient outcomes in different cardiac diseases will start to emerge. If confirmed, these studies should then be coupled with investigations that look for therapies specifically targeted at improving RVEF and patient prognosis.

Conflict of interest

The authors report no relationships that could be construed as a conflict of interest.

References

[1] E. Surkova, D. Muraru, S. Iliceto, L.P. Badano, The use of multimodality cardiovascular imaging to assess right ventricular size and function, Int. J. Cardiol. 214 (2016) 54–69.
[2] H. Magunia, C. Dietrich, H.F. Langer, et al., 3D echocardiography derived right ventricular function is associated with right ventricular failure and mid-term survival after left ventricular assist device implantation, Int. J. Cardiol. 272 (2018) 348–355, https://doi.org/10.1016/j.ijcard.2018.06.026.
[3] M.S. Kiernan, A.L. French, D. DeNofrio, et al., Preoperative three-dimensional echocardiography to assess risk of right ventricular failure after left ventricular assist device surgery, J. Card. Fail. 21 (2015) 189–197.
[4] R.M. Lang, L.P. Badano, V. Mor-Avi, et al., Recommendations for cardiac chamber quantification by echocardiography in adults: an update from the American Society of Echocardiography and the European Association of Cardiovascular Imaging, Eur. Heart J. Cardiovasc. Imaging 16 (2015) 233–270.
[5] D. Muraru, V. Spadotto, A. Cecchetto, et al., New speckle-tracking algorithm for right ventricular volume analysis from three-dimensional echocardiographic data sets: validation with cardiac magnetic resonance and comparison with the previous analysis tool, Eur. Heart J. Cardiovasc. Imaging 17 (2016) 1279–1289.
[6] F. Maffessanti, D. Muraru, R. Esposito, et al., Age-, body size-, and sex-specific reference values for right ventricular volumes and ejection fraction by three-dimensional echocardiography: a multicenter echocardiographic study in 507 healthy volunteers, Circ. Cardiovasc. Imaging 6 (2013) 700–710.
[7] L.P. Badano, F. Boccalini, D. Muraru, et al., Current clinical applications of transthoracic three-dimensional echocardiography, J. Cardiovasc. Ultrasound 20 (2012) 1–22.
[8] Y. Nagata, V.C. Wu, Y. Kado, et al., Prognostic value of right ventricular ejection fraction assessed by transthoracic 3D echocardiography, Circ. Cardiovasc. Imaging 10 (2017).
[9] D. Muraru, S. Onciul, D. Peluso, et al., Sex- and method-specific reference values for right ventricular strain by 2-dimensional speckle-tracking echocardiography, Circ. Cardiovasc. Imaging 9 (2016), e003866.
[10] L.P. Badano, T.J. Kolias, D. Muraru, et al., Standardization of left atrial, right ventricular, and right atrial deformation imaging using two-dimensional speckle tracking echocardiography: a consensus document of the EACVI/ASE/Industry Task Force to standardize deformation imaging, Eur. Heart J. Cardiovasc. Imaging 19 (2018) 591–600.