Taylor & Francis
Taylor & Francis Group

Structural Heart
The Journal of the Heart Team

ISSN: 2474-8706 (Print) 2474-8714 (Online) Journal homepage: https://www.tandfonline.com/loi/ushj20

Moving Beyond Linear Formulas for Left Ventricular Mass in Aortic Valve Replacement

Kegan J. Moneghetti, Sara Bouajila, Yukari Kobayashi, Juyong Brian Kim, William F. Fearon & Francois Haddad

To cite this article: Kegan J. Moneghetti, Sara Bouajila, Yukari Kobayashi, Juyong Brian Kim, William F. Fearon & Francois Haddad (2017) Moving Beyond Linear Formulas for Left Ventricular Mass in Aortic Valve Replacement, Structural Heart, 1:5-6, 298-299, DOI: 10.1080/24748706.2017.1377364

To link to this article: https://doi.org/10.1080/24748706.2017.1377364

Accepted author version posted online: 07 Sep 2017.
Published online: 21 Sep 2017.

STRUCTURAL HEART
2017, VOL. 1, NOS. 5–6, 298–299
https://doi.org/10.1080/24748706.2017.1377364

LETTER TO THE EDITOR

Moving Beyond Linear Formulas for Left Ventricular Mass in Aortic Valve Replacement

Kegan J. Moneghetti, MBBS[a,b,c], Sara Bouajila, MD[a,b], Yukari Kobayashi, MD[a,b], Juyong Brian Kim, MD, MPH[a,b], William F. Fearon, MD[a,b], and Francois Haddad, MD[a,b]

[a]Division of Cardiovascular Medicine, Stanford University School of Medicine, Stanford, California, USA; [b]Stanford Cardiovascular Institute, Stanford, California, USA; [c]Department of Medicine, St. Vincent's Hospital, University of Melbourne, Victoria, Australia

In the well-performed study of Kadkhodayan and colleagues, the investigators suggest the use of the Devereux formula, which relies on linear measurements of left ventricular (LV) dimensions, leads to an overestimate of LV mass regression, particularly in surgical aortic valve replacement (SAVR) patients.[1] Serial measurements presented in 211 patients undergoing AVR provided clear evidence of the limitations of this widely used method to assess LV mass.

It is well established that assessment of LV mass is more precise and reliable by magnetic resonance imaging (MRI), when compared to echocardiography.[2] Using this method, the reader usually assesses short-axis images on a per-slice basis by applying Simpson's method, producing a value of LV mass. Large population data have suggested normative values using this technique, though it is limited in geriatric populations.[3,4] As Kadkhodayan and colleagues suggest it is not surprising that the use of a linear formula on echocardiography would not accurately represent LV remodelling post aortic value replacement.

Use of MRI to assess LV remodeling post Transcatheter Aortic Valve Replacement (TAVR) is of course impractical, not only due to time and expense, but also due to the comorbidities associated with aortic stenosis in these patients. Three-dimensional echocardiography also provides challenges, as echocardiographic windows and definition can be difficult to optimize in this cohort, particularly post-surgery. Recently our group reported changes in LV mass in a cohort of 128 patient undergoing TAVR.[5] In order to address the concerns of the Devereux formula we used the area-length method as described by the American Society of Echocardiography.[6] In addition, we used a threshold of 5% difference between diastolic and systolic calculation of LV mass as a quality metric. While only assessed at a single level, this methodology more closely represents calculation of LV mass by MRI, adding desirable qualities that may better represent left ventricular remodelling: (1) Measurements in end-diastole that can be affected in cases with paradoxical septal motion or a prominent basal septum can be reduced as area is used as opposed to a series of linear measurements; (2) It allows easier identification of the papillary muscles and septal band which often contribute to variability; (3) The formula avoids raising linear measurements to the power of 3, thus reducing the amplification of errors in measurement; and (4) A single parasternal short axis view and apical four chamber view are usually acquired as part of a basic echocardiographic protocol. Using this strategy, our normative values for LV mass and end systolic volume sit between previously published MRI values (Table 1). Obviously the area-length method, has its limitations. The cylinder shape that the formula is based on does not truly reflect the spherical structure that is the LV and a foreshortened apical image could result in an underestimation of LV mass.

In summary, while known limitations in the linear LV mass formula pose a challenge, particularly in elderly patients undergoing AVR, the area-length method is an immediate echocardiographic option available to investigations that may partially address these concerns.

Table 1. Reported distribution of LV end systolic volume index and LV mass index.

	LVESVI (ml/m2)		LVMI (g/m2)	
	Male	Female	Male	Female
MESA Healthy Cohort[3,a]	25 ± 9	18 ± 5	85 ± 15	67 ± 11
Stanford BPCL[b]	33 ± 8	28 ± 8	72 ± 13	65 ± 14
UK BioBank[4,a]	36 ± 8	29 ± 6	53 ± 9	42 ± 7
ASE Guidelines[6,b]	21 ± 5	16 ± 4	50–102[c]	44–88[c]

Note. [a]MRI-derived values.
[b]Echocardiographic-derived values from area length method.
[c]Reference ranges, otherwise values reported represent mean ± standard deviation.
LVESVI, left ventricular end systolic volume index; LVMI, left ventricular mass index; MESA, Multi-Ethnic Study of Atherosclerosis; BPCL, Biomarker and Phenotype Core Laboratory; ASE, American Society of Echocardiography.

CONTACT Kegan J. Moneghetti keganm@stanford.edu 300 Pasteur Drive, Stanford, CA 94305, USA; Francois Haddad fhaddad@stanford.edu 300 Pasteur Drive, Stanford, CA 94305, USA.

Disclosure statement

The authors have no conflicts of interest to report.

References

1. Kadkhodayan A, Lin G, Popma JJ, et al. A paradox between LV mass regression and hemodynamic improvement after surgical and transcatheter aortic valve replacement. *Struct Heart*. 2017;1(1–2):51–61. doi:10.1080/24748706.2017.1322734.
2. Bottini PB, Carr AA, Prisant LM, Flickinger FW, Allison JD, Gottdiener JS. Magnetic resonance imaging compared to echocardiography to assess left ventricular mass in the hypertensive patient. *Am J Hypertens*. 1995;8(3):221–228. doi:10.1016/0895-7061(94)00178-E.
3. Natori S, Lai S, Finn JP, et al. Cardiovascular function in multi-ethnic study of atherosclerosis: normal values by age, sex, and ethnicity. *Am J Roentgenol*. 2006;186(6 Suppl 2):S357–365. doi:10.2214/AJR.04.1868.
4. Petersen SE, Aung N, Sanghvi MM, et al. Reference ranges for cardiac structure and function using cardiovascular magnetic resonance (CMR) in Caucasians from the UK Biobank population cohort. *J Cardiovasc Magn Reson*. 2017;19(1):18. doi:10.1186/s12968-017-0327-9.
5. Kobayashi Y, Kim JB, Moneghetti KJ, et al. Dynamic changes in aortic impedance after transcatheter aortic valve replacement and its impact on exploratory outcome. *Int J Cardiovasc Imaging*. 2017;doi:10.1007/s10554-017-1155-6.
6. Lang RM, Badano LP, Mor-Avi V, 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. *J Am Soc Echocardiogr*. 2015;28(1):1–39 e14. doi:10.1016/j.echo.2014.10.003.