

Characterization of chronic aortic and mitral regurgitation using echocardiography and cardiovascular magnetic resonance

Akademisk avhandling

som för avläggande av medicine doktorexamen vid Sahlgrenska akademi,
Göteborgs universitet, kommer att offentlig förvaras i hörsalen
Arvid Carlsson, Academicum, Medicinargatan 3
Torsdagen den 10 september 2015 kl 13:00

av

Christian Lars Polte

Fakultetsopponent:

Professor Frank Flachskampf
Institutionen för medicinska vetenskaper, Kardiologi
Akademiska sjukhuset, Uppsala

Avhandlingen baseras på följande delarbeten:

- I. *Left ventricular volumes by echocardiography can support the diagnosis of severe chronic aortic and mitral regurgitation: a prospective study using cardiovascular magnetic resonance as reference*
Bech-Hanssen O, Polte CL, Lagerstrand KM, Johnsson ÅA, Fadel BM and Gao SA
Submitted manuscript
- II. *Quantification of left ventricular linear, areal and volumetric dimensions: a phantom and in vivo comparison of 2D and real-time 3D echocardiography with cardiovascular magnetic resonance*
Polte CL, Lagerstrand KM, Gao SA, Lamm CR and Bech-Hanssen O
Ultrasound Med Biol. 2015; 41 (7): 1981-1990
- III. *Mitral regurgitation quantification by cardiovascular magnetic resonance: a comparison of indirect quantification methods*
Polte CL, Bech-Hanssen O, Johnsson ÅA, Gao SA and Lagerstrand KM
Int J Cardiovasc Imaging. 2015; 31 (6): 1223-1231
- IV. *Characterization of chronic aortic and mitral regurgitation benefiting from valve surgery using cardiovascular magnetic resonance*
Polte CL, Gao SA, Johnsson ÅA, Lagerstrand KM and Bech-Hanssen O
Submitted manuscript



UNIVERSITY OF GOTHENBURG
Göteborg 2015

Characterization of chronic aortic and mitral regurgitation using echocardiography and cardiovascular magnetic resonance

Christian Lars Polte

Department of Molecular and Clinical Medicine
Institute of Medicine, Sahlgrenska Academy at the University of Gothenburg

ABSTRACT

Introduction – Grading of chronic aortic (AR) and mitral regurgitation (MR) severity can be obtained by echocardiography and cardiovascular magnetic resonance (CMR). The aims of the four studies were: (1) to establish echocardiographic thresholds for left ventricular (LV) dimensions indicating severe chronic AR or MR, using CMR as reference, (2) to elucidate the main cause of echocardiographic underestimation of LV dimensions compared with CMR, (3) to systematically compare three indirect CMR MR quantification methods ('standard', 'volumetric' and 'flow' method), as well as (4) to establish CMR- and quantification method-specific thresholds indicating hemodynamically significant chronic AR or MR benefiting from surgery.

Methods – The first prospective study comprised a total of 93 (AR (n=44), MR (n=49)), the second 45 (healthy volunteers (n=20), AR (n=17), MR (n=8)), the third 52 (healthy volunteers (n=16), MR (n=36)) and the fourth 78 participants (AR (n=38), MR (n=40)). Two-dimensional (2DE) and real-time three-dimensional echocardiography (RT3DE) as well as CMR was performed in all participants. Operated patients with severe AR/MR, according to 2DE, underwent also post-surgical scans. Furthermore, a multimodality phantom model was investigated.

Results – (1) Linear dimensions could not sufficiently identify severe LV dilatation, in contrast to 2DE volumes, which showed an excellent (AR) or good (MR) diagnostic ability. The diagnostic ability was less powerful for RT3DE volumes. (2) All modalities delineated the phantom model with high precision. *In vivo*, 2DE/RT3DE underestimated LV short-axis end-diastolic linear, areal and all volumetric dimensions significantly compared with CMR, but not short-axis end-systolic linear and areal dimensions. (3) The 'standard' method determined significantly larger regurgitant volumes (RV) and fractions (RF), in contrast to the 'volumetric' and 'flow' method, which determined similar results. This affected the grading of severity in operated MR patients. (4) In operated patients, application of current RF thresholds by CMR led to frequent downgrading compared with 2DE. Furthermore, CMR- and quantification method-specific thresholds were established, which were lower than recognized guideline criteria.

Conclusions – (1) LV volumes obtained by 2DE/RT3DE can support the diagnosis of severe AR and MR, when other causes of LV dilation have been considered. (2) Echocardiographic underestimation of LV dimensions is mainly due to inherent technical differences in the ability to differentiate trabeculated from compact myocardium. (3) The choice of indirect CMR MR quantification method can affect the grading of regurgitation severity and thereby eventually the clinical decision-making. (4) CMR grading of chronic AR and MR severity should be based on modality- and quantification method-specific thresholds to assure appropriate clinical decision-making.

Keywords: Aortic regurgitation • Mitral regurgitation • Grading of severity • Left ventricular dimensions • Echocardiography • Cardiovascular magnetic resonance

ISBN 978-91-628-9467-2 (Printed edition)
ISBN 978-91-628-9468-9 (Electronic edition)
E-publication: <http://hdl.handle.net/2077/38759>