Three-dimensional Echocardiography

von
Thomas Buck, Andreas Franke, Mark J Monaghan

1st Edition.

Three-dimensional Echocardiography – Buck / Franke / Monaghan
schnell und portofrei erhältlich bei beck-shop.de DIE FACHBUCHHANDLUNG

Thematische Gliederung:
Kardiologie, Angiologie, Phlebologie – Kernspintomographie (CT, NMR, MRT, etc.)

Springer 2010

Verlag C.H. Beck im Internet:
www.beck.de
ISBN 978 3 642 11178 5
# Table of contents

1 **Introduction** ........................................ 1
   Thomas Buck, Andreas Franke, and Mark J. Monaghan

2 **Three-dimensional echocardiography: lessons in overcoming time and space** .................. 3
   Jos R.T.C. Roelandt and Joseph Kisslo
   2.1 Reconstruction techniques .................. 3
   2.1.1 The linear scanning approach .......... 4
   2.1.2 The fan-like scanning approach ....... 6
   2.1.3 The rotational scanning approach ....... 6
   2.2 Volumetric real-time (high-speed) scanning .................. 10
   2.3 The future is based on the past .......... 17
   References ........................................... 18

3 **Basic principles and practical application** ........................................ 21
   Thomas Buck (with contribution by Karl E. Thiele, Philips Medical Systems, Andover, MA, USA)
   3.1 How real-time 3D ultrasound works .......... 21
   3.1.1 It's all about the transmit beams .......... 21
   3.1.2 The need for bigger, better, faster .......... 24
   3.1.3 Fully sampled matrix array transducers .......... 24
   3.1.4 Parallel receive beam processing .......... 26
   3.1.5 Three-dimensional color flow .......... 27
   3.2 The probes ......................................... 27
   3.3 Live 3D echocardiographic examination .................. 29
   3.3.1 First steps and learning curve .......... 29
   3.3.2 Three-dimensional acquisition
       (modes and image settings) .................. 29
   3.3.3 Standard 3D views .................. 34
   3.4 Basic 3D analysis: cropping and slicing .................. 40
   3.4.1 First steps of 3D dataset cropping .......... 40
   3.5 Basic 3D measurements .................. 48
   3.6 Artifacts ........................................... 48
   3.6.1 Stitching artifacts .................. 48
   3.6.2 Dropout artifacts .................. 49
   3.6.3 Blurring and blooming artifacts .......... 50
   3.6.4 Gain artifacts .................. 51
   References ........................................... 53

4 **Left ventricular function** ........................................ 55
   Harald P. Kühl
   4.1 Assessment of left ventricular volumes
       and ejection fraction .................. 56
   4.2 Evaluation of left ventricular mass .......... 59
   4.3 Assessment of regional left ventricular function .................. 62
   4.4 Determination of left ventricular dyssynchrony .......... 65
   4.5 Parametric imaging .................. 65
   4.6 Transesophageal real-time 3D echocardiography ............ 67
   4.7 Three-dimensional assessment of left atrial volume and function .......... 68
   References ........................................... 70

5 **Three-dimensional stress echocardiography** ........................................ 73
   Andreas Franke
   5.1 Method .............................................. 73
   5.2 Clinical studies on 3D stress echocardiography .................. 79
   5.3 Limitations ........................................... 80
   5.4 New approaches and future perspectives ........ 80
   References ........................................... 80

6 **Cardiac dyssynchrony** ........................................ 83
   Mark J. Monaghan and Shaumik Adhya
   6.1 Technique ............................................. 83
   6.1.1 Acquisition of 3D volumes .......... 83
   6.1.2 Measures of intraventricular dyssynchrony ...... 83
   6.1.3 Performing 3D analyses .......... 86
   6.1.4 Measurement variability .......... 91
   6.2 Normal values ........................................ 92
   6.3 Dyssynchrony in heart failure and left bundle branch block .......... 93
   6.4 Relationship between left ventricular function
       and dyssynchrony .......... 93
   6.5 Patterns of dyssynchrony .......... 95
   6.6 SDI as a predictor of outcome of cardiac resynchronisation therapy .......... 95
   References ........................................... 97
| 6.5.1 | In children | 97 |
| 6.5.2 | In congenital right heart disease | 97 |
| 6.5.3 | After acute myocardial infarction | 97 |
| 6.5.4 | In amyloidosis | 98 |
| 6.6 | Assessment of dyssynchrony after CRT | 98 |
| 6.7 | Conclusion | 98 |
| References | 99 |

### Table of contents

**6.7 Conclusion**

**References**

**7 The right ventricle**

Stephan von Bardeleben, Thomas Buck, and Andreas Franke

**7.1** Assessment of right ventricular volumes and function | 104

**7.2** New aspects of 3D right ventricular analysis | 107

**References**

**8 Valvular heart disease – insufficiencies**

Thomas Buck

**8.1** Mitral regurgitation | 109

**8.1.1** Evaluation of mitral valve insufficiency | 109

**8.1.2** Classification of mitral valve insufficiency | 111

**8.1.3** Mitral valve prolapse, flail and Barlow’s disease | 112

**8.1.4** Mitral valve quantification | 116

**8.1.5** Papillary muscle rupture | 121

**8.1.6** Functional mitral regurgitation | 122

**8.1.7** Endocarditis | 125

**8.1.8** Mitral valve prosthesis | 126

**8.1.9** Mitral valve repair | 128

**8.1.10** Rare etiologies | 132

**8.1.11** Assessment of severity of mitral regurgitation | 133

**8.2** Aortic regurgitation | 143

**8.3** Right-sided heart valves | 149

**References**

**9 Valvular heart disease – stenoses**

Jose L. Zamorano and Jose Alberto de Agustín

**9.1** Evaluation of mitral valve stenosis | 155

**9.1.1** Morphological assessment of the mitral valve | 155

**9.1.2** Functional assessment of mitral stenosis | 155

**9.2** Evaluation of aortic valve stenosis | 162

**9.2.1** Morphological assessment of aortic stenosis | 162

**9.2.2** Functional assessment of aortic stenosis | 164

**9.3** Evaluation of tricuspid and pulmonary valve stenosis | 171

**9.4** Evaluation of prosthetic and reconstructed valves | 171

**References**

**9.5** In children | 172

**9.6** In congenital right heart disease | 172

**9.7** After acute myocardial infarction | 172

**9.8** In amyloidosis | 172

**9.9** Assessment of dyssynchrony after CRT | 172

**References**

**10 Three-dimensional echocardiography in adult congenital heart disease**

Folkert J. Meijboom, Heleen van der Zwaan, and Jackie McGhie

**10.1** Patent foramen ovale | 177

**10.2** Atrial septal defect | 177

**10.3** Ventricular septal defect | 182

**10.4** Atrioventricular septal defects | 184

**10.5** Ebstein’s anomaly | 187

**10.6** Transposition of the great arteries | 189

**10.7** Congenitally corrected transposition of the great arteries | 191

**10.8** Tetralogy of Fallot | 193

**10.9** RT3DE in other congenital cardiac malformations | 193

**10.10** The role of RT3DE in the analysis of right ventricular function | 193

**10.10.1** Acquisition | 193

**10.10.2** Analysis | 196

**10.11** Conclusion | 196

**References**

**11 Congenital heart disease in children**

John M. Simpson

**11.1** Technical and patient-specific factors | 201

**11.2** Selection of imaging probes in children | 202

**11.3** Presentation of 3D echocardiographic images | 203

**11.4** Types of cardiac lesions which can be assessed using 3D echocardiography | 203

**11.4.1** Abnormalities of venous drainage | 203

**11.4.2** Atrial septal defects | 203

**11.4.3** Ventricular septal defects | 204

**11.4.4** Atrioventricular valves | 208

**11.4.5** Atrioventricular septal defects | 208

**11.4.6** Mitral valve abnormalities | 208

**11.4.7** Ebstein’s anomaly of the tricuspid valve | 208

**11.4.8** Atrioventricular junction | 208

**11.4.9** Complex anatomy | 212

**11.5** Three-dimensional echocardiography during catheter intervention and surgery | 214

**11.5.1** Imaging during catheter intervention | 214

**11.5.2** Three-dimensional imaging during surgery | 214

**11.6** Role of RT3DE in the assessment of cardiac function in children | 217
11.6.1 The left ventricle ........................................... 217
11.6.2 The right ventricle ...................................... 217
11.7 Conclusions ..................................................... 219
References .......................................................... 219

12 Cardiac tumors and sources of embolism .................. 223
Björn Plicht
12.1 Sources of embolism ......................................... 223
12.1.1 Cardiac and vascular thrombi, spontaneous echo contrast ................. 223
12.1.2 Patent foramen ovale ...................................... 226
12.1.3 Infective endocarditis ....................................... 231
12.2 Primary cardiac tumors ...................................... 233
12.2.1 Primary benign cardiac tumors ............................. 233
12.2.2 Primary malignant tumors .................................. 236
12.3 Secondary cardiac tumors and metastases .................. 236
References .......................................................... 239

13 Monitoring and guiding cardiac interventions and surgery .... 241
Harald P. Kühl, Andreas Franke, and Thomas Buck
13.1 Method ............................................................. 241
13.2 Intraoperative monitoring and guiding ......................... 241
13.3 Periinterventional monitoring and guiding ...................... 244
13.3.1 Transcatheter closure of PFO and ASD .................... 244
13.3.2 Transcatheter closure of VSD ............................... 248
13.3.3 Percutaneous aortic valve implantation ...................... 248
13.3.4 Percutaneous mitral repair .................................. 249
13.3.5 Left atrial appendage occluder implantation ............... 256
13.3.6 Percutaneous occluder implantation for paravalvular leaks .................. 258
13.3.7 Percutaneous mitral valvuloplasty ............................ 259
13.3.8 Electrophysiological procedures ............................ 263
13.4 Conclusion ......................................................... 263
References .......................................................... 263

Subject index ......................................................... 267