The annual meeting of the European Association of Echocardiography (EuroEcho and other Imaging Modalities) was held in Budapest, Hungary. In the present paper, we present a summary of the ‘Highlights’ session.

Keywords
Left ventricular mechanics • 3D Echocardiography • Cardiac computed tomography • Cardiovascular magnetic resonance • Congenital heart diseases • Heart valve disease

Introduction
The annual meeting of the European Association of Echocardiography (EuroEcho and other Imaging Modalities) was held in Budapest, Hungary. The meeting was dedicated to a more comprehensive assessment of the ‘clinical scenario’ with the objective of focusing on how imaging modalities—based on an integrated cardiovascular imaging approach—affect clinical decision-making and outcome. The total attendance of the meeting was over 3500 participants and 690 abstracts were selected for presentation. The last day of the meeting, the ‘Highlights’ session wrapped up the event with a summary of the most relevant abstracts presented throughout the congress. A short report of this session is presented below.

Heart valve diseases
Magne et al. tested the prognostic value of exercise pulmonary hypertension in patients with asymptomatic severe aortic stenosis. Exercise pulmonary hypertension is frequent (55%), associated with reduced cardiac event-free survival and with a high rate (12%) of cardiovascular death. Its prognostic importance remains significant when adjusted with exercise-induced changes in the mean pressure gradient. The prevalence and characteristics of paradoxical low-flow, low-gradient severe aortic stenosis were assessed on a cardiac catheterization study: 106 of 780 patients (13%) with aortic valve area $\leq 1\text{ cm}^2$ and aortic valve area index $\leq 0.6\text{ cm}^2/m^2$ had a low mean gradient (<40 mmHg) and low flow (<35 mL/m²). These patients were older, more frequently women, had reduced arterial compliance, a high valvulo-arterial impedance, and worse symptomatic status. It is important to recognize this entity. In patients with severe aortic stenosis, delayed reporting of symptoms is common. The Vienna group observed that symptoms are reported earlier in patients enrolled in a follow-up programme, which results in an optimized timing of aortic valve surgery.

In an experimental study in a canine model producing acute aortic regurgitation of differing severity, apical rotation was well correlated with invasive measurement of $\frac{dp}{dt}$ ($r = 0.71$). Speckle-tracking echocardiography was performed in healthy subjects and in patients with asymptomatic or symptomatic chronic aortic regurgitation. Patients with asymptomatic aortic regurgitation had increased apical rotation and twist, whereas symptomatic patients demonstrated reduced left ventricular (LV) torsion, circumferential and radial strains. Reduced global longitudinal strain best predicted heart failure symptoms. A similar study from Leiden, in patients with aortic regurgitation, revealed that multidirectional myocardial strains were significantly more impaired in symptomatic patients. In asymptomatic patients, LV longitudinal strain identified patients who later developed indications for aortic valve surgery. The accuracy of 3D (three-dimensional) transthoracic echo was tested for the quantification of aortic
root geometry and volume: an excellent correlation was found with volume measured by computed tomography \( (R^2 = 0.93). \)\(^7\) In 395 patients referred for aortic valve surgery or aortic root repair, no significant dilatation of the aorta at both the sinus of Valsalva and ascending aortic levels was observed in patients with a bicuspid valve when compared with tricuspid valve up to 5 years following surgery.\(^8\) The prevalence of bicuspid aortic valve in subjects with a Marfan syndrome was found to be similar to the prevalence in general population. When bicuspid valve and Marfan syndrome co-exist, the dilatation of the aorta is observed at the level of sinus of Valsalva. The leaflet morphology was frequently type I.\(^9\) The prognostic importance of the brain natriuretic peptide (BNP) level was tested in asymptomatic patients with degenerative mitral regurgitation. LV longitudinal function and left atrial volume are the main determinants of BNP release. BNP is a powerful independent predictor of cardiac events and may help to improve risk stratification.\(^10\)

**Left ventricular mechanics and function**

The following paragraph can summarize only a fraction of the many good and interesting abstracts on LV mechanics and function, which were presented throughout the meeting. Main topics were the feasibility of 2D and 3D speckle tracking and its application in clinical and physiological studies. Dalen et al.\(^11\) from Trondheim showed that the simple measurement of mitral valve plane motion is a good surrogate of LV function. If indexed to LV length, values are comparable with global longitudinal strain measurements by speckle tracking. This may be of importance in patients with bad image quality where speckle-tracking technology often fails. Two abstracts from Parisi et al.,\(^12\) Naples, and Lilli et al.\(^13\) demonstrated the strong dependence of LV twist estimates from the position of the apical short-axis plane which results in a relevant underestimation of LV twist if the apical image plane is positioned too basal. Liu et al.\(^14\) from Würzburg demonstrated by both speckle tracking and tissue Doppler a significant base-to-apex gradient of longitudinal strain in patients with amyloidosis, while this was not possible in controls. If specific for amyloidosis, this finding would be a helpful clinical marker. Otherwise it must be interpreted as a result of a thickened LV wall. Several authors presented studies on layer-specific changes in regional myocardial deformation in the clinical setting of coronary artery disease. Sarvari et al.\(^15\) from Oslo showed that significant coronary stenosis is best detected by strain measurements in the subendocardial layer, which may have a relevant impact on the ongoing discussions on standardization of deformation measurements for clinical applications. The maturation of speckle tracking now allows reproducing the earlier tissue Doppler-based finding that post-systolic longitudinal shortening is a sensitive marker of induced myocardial ischaemia during stress echocardiography.\(^16\) Uusitalo et al.\(^17\) from Turku could demonstrate by 2D tracking its significant increase in ischemic segments compared with no change in non-ischaemic myocardium. The ability of 3D speckle tracking to detect infarct scar, as defined by cardiovascular magnetic resonance (CMR)-delayed enhancement, was investigated by Muraru et al.\(^18\) from Padua and Amzulescu et al.\(^19\) from Leuven. While Muraru et al. found circumferential strain to be the best indicator of both infarct size and transmurality of scar, Amzulescu et al. found a similar performance of all three strain components with good ability to detect transmural scars and less ability to characterize transmurality. Interestingly in the latter study, none of the 3D-derived deformation components was superior to Doppler-derived longitudinal strain. The most interesting new development in myocardial function imaging was presented in two abstracts from Paris. ‘Shear wave imaging’ analyses the propagation of mechanical waves in the myocardium with high frame rate ultrasound, which originate from a single strong focused ultrasound impulse. While Lee et al.\(^20\) showed that layer-specific myocardial fibre direction can be measured based on the differential propagation speed of shear waves in different directions, Couade et al.\(^21\) demonstrated a strong relation between the shear wave-based estimate of myocardial stiffness and myocardial contractility in an ex vivo beating heart model. This work may bring imaging closer to the ‘Holy Grail’ of non-invasive contractility assessment and was deservedly awarded with the EAE young investigator award 2012.

**3D Echocardiography**

This year three-dimensional echocardiography (3DE) has been a highly popular echo modality among the original abstract submissions. Seventy-six (11%) of all accepted abstracts were about 3DE with an increase by 55% compared with abstracts accepted during 2010. Among the 3DE abstracts, the most popular topics have been myocardial mechanics (3DE strain) with 17 abstracts (22%), and assessment of left atrial size and function with 14 abstracts (18%). Hjertaas et al.\(^22\) performed an in vitro study to assess the optimal temporal resolution for 3DE strain assessment and they found that single-beat acquisitions showed a limited spatial and temporal resolution that made it unsuitable for 3D strain assessment. However, too high temporal resolution was also detrimental and the optimal one was six-beat acquisition at 37 vps. Trache et al.\(^23\) compared 2D and 3DE strain and found that the best correlation was between 3D area and 2D longitudinal strain \( r = 0.81 \). Mor-Avi et al.\(^24\) performed a multicentre study to assess the accuracy of 3DE in measuring left atrial volume in 100 patients who underwent CMR. They found that 3DE left atrial volumes were better correlated \( r = 0.83 \) with lower bias than 2DE \( r = 0.74 \) with CMR. Intra- and interobserver reproducibility of left atrial volumes assessed with 3DE and 2DE were similar and significantly higher than CMR. Buechel et al.\(^25\) validated left atrial volumes using the same software in 40 patients undergoing CMR before pulmonary vein isolation. Using the same software, Guimarães et al.\(^26\) and Muraru et al.\(^27\) provided reference values in healthy children and adults, respectively. Maffessanti et al.\(^28\) quantified changes in the shape of the left atrium during the cardiac cycle. Clausen et al.\(^29\) highlighted the pivotal role of transoesophageal 3DE to measure correctly the size and shape of the left atrial appendage orifice. Finally, Marek et al.\(^30\) documented the role of transoesophageal 3DE in differentiating left atrial appendage thrombosis from trabeculae. 3DE was also used in other clinical settings. Adhya et al.\(^31\) used 3DE to assess the extent of persistent...
dyssynchrony after CRT and found that device optimization in patients with SDI >8.0 after 3 months from implant significantly increased the number of CRT responders. Skidan et al. compared two softwares for the measurement of right ventricular (RV) volumes and found no difference in accuracy between the software specifically designed for the RV and the generic software designed for LV volume in comparison with CMR. Grapsa et al. found that in patients with pulmonary hypertension, RV volumes increase and ejection fractions decrease over time and 3DE is as accurate as CMR in detecting RV remodelling in these patients. Finally, 3DE was used to assess heart valve function, and to identify candidates for percutaneous valve procedures.

Cardiac computed tomography

While small in overall numbers, several interesting studies on cardiac computed tomography (CT) were presented this year. Capoulade et al. assessed the relation between aortic valve calcification on CT and haemodynamic severity of aortic stenosis as determined by echocardiography. In their population of 80 patients with aortic stenosis, the authors found a significant correlation between the mean valvular pressure gradient and the quantity of calcium in the aortic valvular cusps ($r = 0.69, P = 0.0001$), but not for calcification of the aortic root or the aortic valve annulus. The correlation between calcium volume and haemodynamic significance was much better for tricuspid compared with bicuspid aortic valves. Receiver operating characteristic (ROC) analysis demonstrated that an area under the curve of 0.82 could be achieved, using a cut-off cusp calcium volume of 1.37 cm$^3$, to identify severe tricuspid aortic valve stenosis. The relation between aortic valve sclerosis and coronary artery disease was investigated by Ann et al. in 100 patients who underwent cardiac CT, echocardiography, and invasive coronary angiography. Echocardiographic aortic valve sclerosis correlated with aortic valve calcification on CT, but not with the amount of coronary calcium or the presence of obstructive coronary artery disease on invasive angiography. Several abstracts were devoted to the prognostic value of non-invasive coronary angiography by cardiac CT. Cabeza Lainez et al. confirmed the good prognostic value of a negative CT angiogram. In a symptomatic population, 74% (217/292) of the patients did not have >50% coronary lumen obstruction, which was associated with a 99% negative predictive value for the occurrence of death, myocardial infarction (MI), or unstable angina at 18 months. In a population of 404 patients with a mean follow-up of 15 months, Barros et al. demonstrated that coronary disease on cardiac CT outperformed functional angiina class, nicotine abuse, and diabetic status for the occurrence of death, non-fatal MI, unstable angina, hospitalization, and coronary revascularization. In a population ($n = 381$) that underwent both exercise electrocardiography and single-photon emission computed tomography myocardial perfusion imaging, Becherka et al. demonstrated that stress perfusion imaging outperformed exercise test results in terms of predicting adverse outcome defined as death, acute coronary syndrome, hospitalization, and revascularization after a mean follow-up of 58 months.

Cardiovascular magnetic resonance

CMR is a technique with its specific strengths and weaknesses and for a lot of indications it positions itself as a second line method when echocardiography cannot answer a specific clinical question; in a growing number of pathologies, however, CMR plays a primary role in diagnosis, pathologies, and follow-up of patients. For several parameters, i.e., volumes and function, it is the gold standard against which other modalities are tested. Also, in this meeting several abstracts used CMR as the ‘golden’ comparator. Gerlach et al. used gadolinium late enhancement to determine the location and extent of MI and they found that post-systolic motion was inconsistently present in the infarct territory but also occurred in remote areas. Descalzo et al. related the resolution of ST-segment elevation in MI and found a correlation not only with time to revascularization, but also with myocardium at risk, salvage, and subsequent remodelling. Bonadad et al. showed convincingly that not so much the presence of ischemia or scar but the larger extent of ischemia carries the most severe negative prognosis; from this observation follows the need to quantify ischaemia to make the right treatment decision for patients with coronary disease. Hrynchyshyn et al. examined the impact of afterload increase on the remodelling of the ventricle using CMR and could show that wall stress is an important determinant. Several abstracts looked at valve morphology and function. Mällessanti et al. undertook a detailed study of the tricuspid valve determining its shape and displacement during the cardiac cycle. Helvacıoğlu et al. compared the mitral orifice size on echo and CMR but also showed that CMR-determined peak flows across the valve were comparable with the standard Doppler parameters. Cawley et al. undertook a very comprehensive study of aortic and mitral regurgitation, comparing the accuracy and reproducibility of several CMR and echo methods. Bonello et al. had some interesting observations in the CMR follow-up of patients after biventricular repair of pulmonary atresia among which a mid-myocardial gadolinium late enhancement of the RV, an observation known in the LV but not fully understood. Fibrosis in general was an important topic in this meeting where CMR has much to contribute, both for localized and also for diffuse fibrosis. Pratali et al. showed the impact of localized fibrosis on function both at rest and during stress in ischaemic heart disease, while Pisciella et al. characterized in detail the location and extent of fibrosis in hypertrophic cardiomyopathy. Finally, A. Flett extended our knowledge on the possibilities of CMR to quantify diffuse fibrosis and A. Gittenberger-de Groot showed very convincingly that fibroblasts play a very important role in the normal development of the heart but could also be relevant to repair mechanisms after MI and in other pathologies.

Congenital heart diseases

At EuroEcho and other Imaging Modalities 2011 the congenital heart disease (CHD) group, representing the Imaging Working Group of the Association of European Paediatric Cardiology (AEPC) and the Grown Up Congenital Heart (GUCH) working
group of the European Society of Cardiology (ESC), had for the first time a dedicated programme track with several teaching courses and a CHD oral abstract session. There were 35 CHD abstracts submitted. Shiina et al.54 showed the presence of LV diastolic dysfunction in adults with Ebstein's anomaly (EA) after tricuspid valve repair or replacement and suggested that congenital pathological changes of the LV in EA were concealed due to the LV under-filling. When compared with healthy controls, patients with EA have enlarged RV but diminished LV volume.55 In these patients, the severity of tricuspid regurgitation (TR) is directly related to VO2max. Komar et al.56 showed that atrial septal defect (ASD) closure in patients with borderline (Qp:Qs ratio < 1.5) shunt resulted in clinical and haemodynamic improvement. The same authors57 showed that the apical longitudinal peak systolic strain parameters were higher in ASD patients compared with controls and correlated with the parameters of the exercise test. The authors concluded that 2D ultrasound speckle-tracking imaging permits assessment of RV function in patients with ASD and, by measuring RV function using speckle tracking, we might predict exercise tolerance in ASD patients. Van Den Bosch et al.58 presented data on the impact of RV dilatation on LV twist in adult patients with corrected Tetralogy of Fallot (ToF) using speckle tracking. They concluded that in patients with no twist, RV volumes were significantly increased compared with the patients with reduced LV twist. Rigid body rotation was found in 33% of patients; this related strongly with increased RV volumes and elevated NT-proBNP levels. RV dilatation in ToF may negatively influence LV function by reduction in LV twist. Dragulescu et al.59 showed that RV deformation was significantly decreased in the ToF group compared with controls. Correcting RV deformation for RV dilatation could theoretically better represent RV function. Schuuring et al.60 investigated whether Bosentan, an endothelin-1 receptor antagonist, increased cardiac output in Fontan patients by reducing the PVR. Their preliminary data were not able to show any objective improvement. Kusmierek-Cydzorssz et al.61 reported in Eisenmenger syndrome (ES) that 6-month Bosentan therapy resulted in significant increase in tricuspid annular plane systolic excursion and thickening of right ventricular outflow tract muscle, which was parallel with improved functional capacity assessed by 6-minute walk test. Moceri et al.62 hypothesised that although the ‘standard’ long-axis RV evaluation was not different in ES compared with other causes of pulmonary hypertension, the improved survival observed in ES may be explained by a different pattern of RV contraction in ES patients with a major role for the radial contraction. Bellsham-Revell et al.63 compared TR in hypoplastic left heart syndrome by echocardiography and CMR. Except for a single case of severe TR there was little concordance between echo and CMR TR%. The same author64 then reported a significant prolongation of isovolumic time intervals with preservation of systolic and diastolic time in children with hypoplastic left heart syndrome compared with normal children. The CHD programme track was an unqualified success, and for the first time grouped together common themes across various working groups.

Conflict of interest: L.B. has received equipment grants from GE Healthcare and is on the speakers’ bureau of this company. Other authors have no conflict of interest to declare.

References