Implanted cardiac devices not only treat life-threatening arrhythmias effectively, but also provide further detailed information about arrhythmia and device functions in life and after death. The purpose of this study was to analyse if post mortem "interrogation" of cardiac devices offers valuable clues to the circumstances of uncertain deaths.

Methods and Results: We analysed 136 cardiac implantable devices from patients autopsied from January 2012 to October 2016. Median patient age at time of death was 76.4 years. The explanted devices included 100 pacemakers, 19 implantable cardioverter-defibrillators (ICDs), 12 cardiac resynchronization therapy (CRT) systems, and 7 event recorders. The longest retrievable time since implantation was 10 years. 49 (34.0%) devices were low on battery, i.e. ERI or EOL. Arrhythmic periods could not be analysed in some devices because of erased memory due to low battery. In 26 cases, time of death could not be determined exactly by forensic methods. Information retrieved from the devices, especially occurrence of atrial and ventricular arrhythmias, stimulation ratio, and changes of capture threshold or lead impedance using the zoom function, was matched with the forensically diagnosed time and cause of death. Analysis of device-related information made determination of the time of death possible in 104 cases (75.9%). Lead impedances tended to rise after the time of death. With abruptly rising lead impedances the highest levels of the device expansion could be determined. First analysis showed that ventricular tachycardia and fibrillation was present in several cases and was related to the estimated time of death in some cases. Artifact sensing was common after expansion, but also between the time of death and autopsy.

Conclusions: Extracted data from implanted cardiac devices add valuable information to forensic evaluation. The exact analysis and differentiation of cardiac arrhythmias is crucial to determine time and cause of death. Changes of parameters such as lead impedance or capture threshold can provide additional clues. Should a routine post mortem analysis of implantable cardiac devices be installed? To avoid battery discharge and excessive artefact generation device interrogation should happen before autopsy.

1303
12-lead ECG algorithm to differentiate between ARVC and cardiac sarcoidosis
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Background: Cardiac sarcoidosis (CS) can mimic ARVC. CS is characterized by granuloma formation creating confluent, transmural scars which may result in local conduction disturbances and late activation of RV areas. ARVC is characterized by fibrofatty replacement progressing from epicardium to endocardium which may result in gradual activation delay and late activation of low voltages RV areas.

Purpose: To develop a specific 12-lead ECG algorithm to distinguish CS from ARVC.

Methods: Consecutive pts with ARVC (TF and ARVC associated mutation) and CS with dominant RV involvement undergoing VT ablation were enrolled from 2 centers. A non-paced 12-lead ECG was obtained prior to ablation. Based on the assumption that late activated areas have preserved voltage vs. low voltage in CS and ARVC a high sensitivity and specificity for CS (figure).

Results: A total of 44 pts were included (45+17 years, 80% male; 33% [75%] ARVC, 11 [25%] CS). A terminal S-wave in V1-V3 was present in 23 (70%) ARVC pts but in no CS pt. The R in V1 was dominant (R'/R>1) in 29 (68%) ARVC pts and in 1 pt with CS (P=0.001). R-wave amplitude was smaller in ARVC (0.00–0.00 vs. 0.45 (0.25–0.63) mV; P=0.001). optimal R’ cutoff amplitude to distinguish CS from ARVC was 0.20 mV (AUC 0.95). Subsequently, a 3-step algorithm was proposed with a high sensitivity and specificity for CS (figure).

Conclusion: Our proposed, easily applicable 12 lead ECG algorithm can distinguish ARVC from CS with RV involvement. The specific ECG features likely reflect different scar patterns.

1304
Coexistence of atrial and ventricular tachyarhythmias in patients with tetrology of fallot
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Introduction: As the adult population of patients with Tetrology of Fallot (TOF) is increasing, knowledge of their long term sequelae is a necessity.

Purpose: Aim of this study is to examine the incidence and coexistence of supra-ventricular and ventricular tachycardia (SVT, VT) and its relation to survival in TOF patients with long term follow-up.

Methods: All adult patients with corrected TOF from our outpatient clinic were included. Medical correspondence, electrocardiograms(ECG) and 24-hour Holter registrations were reviewed for documentation of atrial fibrillation(AF), SVT and AF and ventricular fibrillation(VF). Event-free and overall survival estimates were obtained with the Kaplan-Meier method.

Results: In total, 236 patients(131 male/56%, 121/1979 years) were included with a follow-up of 34.9±16.4 years. SVT was present in 81 patients(34%), including SVT(N=72, 30%) and AF (N=30, 11%), whereas ventricular arrhythmias were observed in 45 patients(19%), including VT (N=42, 17%) and VF (N=6, 4%). Median event-free survival for SVT, AF, VT and VF was respectively 47, 57, 56 and 60 years after TOF correction (p<0.001). SVT and AF coexisted in 21(26%), while VT and VF coexisted in only 6(13%). In patients with atrial tachyarhythmias, ventricular tachycardias developed in 14 patients(17%). Overall survival rate was >80% up to 45 years of follow-up and decreased drastically in case of right and left ventricular dysfunction. Presence of arrhythmias did not influence survival rates in our cohort.

Conclusion: Coexistence of SVT and AF occurs frequently, whereas coexistence of VT and VF is present in a minority of patients. Development of ventricular arrhythmias after atrial arrhythmias is common. Mortality rates are not influenced by presence of arrhythmia, but severely influenced by right or left ventricular dysfunction.

1305
Heart Rate Variability by mobile app 'ELITE HRV' is not the same as computed from an ECG
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Introduction: Heart rate variability (HRV) is ideally measured from an ECG but other non-ECG signals are being used, particularly by mobile devices. "ELITE HRV" (for iOS and Android) is one of the most popular free mobile apps that is able to calculate HRV by smartphones.

Purpose: The study aim was to analyse the standard time domain parameters of HRV by comparing the ECG-based vs the mobile approach. The classic approach uses an ECG and known mathematical algorithms to obtain HRV, while the mobile approach computes HRV from non-ECG signals, e.g. derived by a chest heat rate monitor (HRM) and a special mobile app.

Methods: 29 healthy individuals (21-30 years old; 14 women) underwent a simultaneous acquisition of the 5-minute ECG (Port 17, TMSI, The Netherlands) and heart rate signal by using the chest HRM (HT, Finland). Recordings of the ECG and chest HRM at rest and during a mental stress test were made in the supine position. Together, 168 five-minute recordings were collected. For the classic HRV computation, after detailed ECG analysis, the measured RR intervals with their corresponding annotations by the in-house software USA were used. For the mobile app approach, the recorded heart rate was directly uploaded by the "ELITE HRV" app from the Polar H7 HRM (Polar, Finland) and computed by a smartphone. For the classic HRV analysis, the RR intervals of only sinus origin in the range of 400-1500 ms were used. For the mobile app HRV analysis, no information was available about what filters were used. Fastest (Pearson) correlation, and the Bland-Altman analysis were applied for the statistical analysis of mean RR interval, the Standard Deviation of Normal-to-Normal (SDNN) of RR intervals, and the Root Mean Square of the Successive Differences (RMSSD) between RR intervals.

Results: The classic approach showed that 68 out of 168 (40.5%) of the analysed recordings contained either non-sinus beats or artefacts (0.7/-2.2% of such intervals). Similar information on disqualified beats was unavailable from the "ELITE HRV" app. Comparing mobile HRV with the classic HRV approach, the mean RR intervals were significantly longer (903.0±161.0 vs 896.0±162.7 ms, p=0.0378) while both SDNN (65.5±30.8 vs 71.1±21.8 ms; p=0.0001) and RMSSD (54.8±36.4 vs. 59.9±34.8 ms; p=0.0584) were smaller with biases of 7, 3.1 and 5.2 ms, respectively. The strongest correlation between both approaches was observed for the mean RR (r=0.97; p=0.0001), whereas SDNN (r=0.85; p=0.0001) and the weakest for RMSSD (r=0.62; p=0.0001). Conclusion: The results of time domain HRV analysis by mobile vs classic approach for the same parameters are neither identical nor perfectly correlated. There is no information provided by the "ELITE HRV" mobile app on the quality of the analysed signal and what types of filters were applied. It appears
Abstract 1304 Figure. Longterm Survival of TOF Patients.
that the “ELITE HRV” app gives different results from the classic HRV approach and for this reason should be used with caution.

1306
Fast simulation of standard 12-lead ECG and 3d ventricular activation
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Introduction: Computational cardiac electrophysiology models that are capable to deliver physiologically motivated 3D ventricular activation maps and the corresponding body surface ECGs are currently only feasible on supercomputers. The fact severely limits the applicability of such models in the clinical practice. Modern ECG imaging tools rely on simplified electrophysiology models, that do not account for the heterogeneity and anisotropy in the electric conductivity of the heart and the torso. Additionally, these tools are often limited to the epicardium only, providing no insights on the 3D volumetric activation.

Purpose: We investigated a computational model using simplified electrophysiological properties for simulating ventricular activation and standard 12-lead ECG with accurate patient-tailored anatomy almost real-time on a desktop computer.

Methods: We developed an in-silico software, based on the eikonal model and the lead-field approach, that simulates the 3D ventricular activation at 1mm resolution and the 12-lead ECG at 1kHz sampling rate in less than a second on modern GPGPU architecture. The eikonal model describes the propagation of the activation front throughout the myocardium. The input parameters for this model were anatomy of the heart and torso, local electric conductivities, possibly heterogeneous and anisotropic, and the early activation sites. Anatomically accurate heart-torso geometries of 6 candidates to cardiac resynchronisation therapy were segmented from MRI, and state-of-the-art bidomain simulations tailored to each patient were performed. For these 6 patients, the new simple model was validated against bidomain simulations performed on a supercomputer with respect to accuracy in the ventricular activation and ECG.

Results: For all 6 patients, the ventricular activation compared well between our model and the bidomain. The absolute error in the activation time was 11.3±4.7ms for 90% of the computational grid points (the total number of nodes was roughly between 200k and 500k). Corresponding QRS-complexes were also accurately reproduced in terms of duration, amplitude, shape and signed area. The absolute error in the QRS duration was between 0.02ms and 2ms. Calculations were performed within 0.3 seconds (best case) to 0.8 seconds (worst case). Additionally, for one patient (see Figure) the activation map and the ECG derived from the simple model closely mimicked the map (filled circles in the bull’s eye plot) and ECG provided by the measurements.

Conclusion: The eikonal model with the lead-field approach can provide patient-tailored, ventricular activation and surface ECG almost real-time on a desktop computer. This makes the method suitable for ECG imaging techniques and interactive simulation tools, bridging the gap between the clinical practice and state-of-the-art cardiac electrophysiology modeling.