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Atrial fibrillation effects on coronary perfusion across the different myocardial layers: a computational analysis

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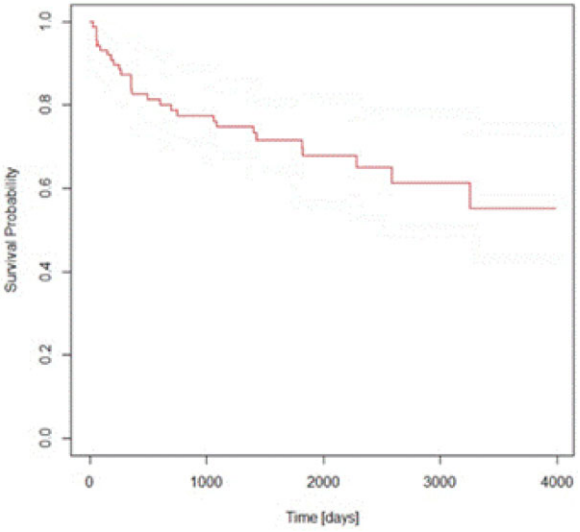
ARRHYTHMIAS

99 New onset atrial fibrillation in STEMI patients: main prognostic factors and clinical outcome

Beatrice Dal Zotto[1], Lucia Barbieri[1], Gabriele Tumminello[2], Massimo Saviano[1], Domitilla Gentile[1], Stefano Lucreziotti[2], Loredana Frattini[2], Diego Tarricone[2], and Stefano Carugo[1]
[1]UOC Cardiologia, Fondazione IRCCS Ca' Granda, Ospedale Maggiore Policlinico, Italy, and [2]UOC Cardiologia, ASST Santi Paolo e Carlo, Italy

The treatment of patients with known atrial fibrillation (AF) undergoing percutaneous coronary intervention has clear indications in the actual guidelines. Remarkable lack of evidence regarding new-onset AF (NOAF) in particular during STEMI is the reason for this study. We retrospectively analysed 1455 consecutive STEMI patients. The primary outcomes are in-hospital, 1-year and long-term follow-up mortality. Cerebral ischaemic events and major bleedings were considered clinical endpoints at 1 year. NOAF was detected in 102 subjects, 62.7% males, mean age 74.8 ± 10.6 years. Mean left ventricular ejection fraction (LVEF) was 43.5 ± 12.1% and left atrial enlargement (58 ± 20.9 ml) was observed. Anterior STEMI accounted for the majority (46%). NOAF has been predominantly recorded in the acute phase (mean duration of 8.1 ± 12.5 h). CHA_2DS_2-VASc score >2 was recorded in 83% of cases, while HAS-BLED score of 2 or 3 was the most represented. All patients acutely received enoxaparin, but only 21.6% were discharged on oral anticoagulation (OAC). In-hospital mortality was 14.2%, while 1-year and long-term mortality were 17.2% and 32.1%, respectively. We identified age as an independent predictor of short- and long-term mortality, while LVEF was the only other independent predictor for in-hospital mortality and arrhythmia duration for 1-year mortality. After 1-year of follow-up we recorded three ischaemic events and no major bleeding. In conclusion, STEMI patients who present NOAF are a very high-risk population with increased short- and long-term mortality. Our data suggest that the indication for OAC should be always driven by CHA2DS2-VASC and HAS-BLEED score, even in patients with a single episode indeed.



99 Figure 1 Kaplan-Meier curve representing the long-term survival of the entire population from hospital admission up to the maximum follow-up time was performed

283 His bundle pacing: safety, performance, and clinical outcomes in a single-centre experience

Lorenzo Bartoli[1,2], Giuseppe Pio Piemontese[1,2], Giulia Massaro[1], Andrea Angeletti[1], Giovanni Statuto[1], Cristian Martignani[1], Matteo Ziacchi[1], and Mauro Biffi[1]
[1]IRCCS Policlinico Sant'Orsola-Malpighi, Italy, and [2]DIMES—Dipartimento di Medicina Specialistica, Diagnostica e Sperimentale, Italy

Aims: Permanent His bundle pacing (HBP) is a more physiological technique for cardiac stimulation and has recently emerged as an alternative for anti-bradycardia pacing and cardiac resynchronization therapy (CRT). Its main advantages over 'classical' pacing are both its protective role over pacing-induced cardiomyopathy and the possibility of resynchronization by normalization of His-Purkinje activation. To evaluate the intermediate-term outcomes of HBP in terms of safety, performance, and clinical outcomes.
Methods and results: Between December 2018 and July 2020, we enrolled a series of consecutive patients with indication for pacing in whom HBP was attempted. A specific lead (3830 Select Secure MRI SureScan) and sheath (C315His) was used. At follow-up clinical, safety and performance outcomes were evaluated. A significant rise in HBP pacing threshold was defined as an increase of at least 1 V@1ms in the minimum voltage that could produce an effective myocardial depolarization. Remote or in-hospital device interrogation was performed by an experienced electrophysiologist. HBP was attempted in 99 patients and all implantations were performed by the same two operators. Eighty-two procedures were successful (83%). The main reasons for HBP failure were high pacing-thresholds ($n = 8$, 47%), infra-Hisian block ($n = 5$, 29,4%), difficult HB location ($n = 3$, 17,6%), unsatisfactory sensing ($n = 1$, 5,9%), or lead instability ($n = 1$, 5,9%). During a mean follow-up of 9.5 ± 5.9 months, the overall technical and clinical complication rates were 39% and 13.3%, respectively. Three (3.6%) patients underwent His lead extraction and subsequent conventional right ventricular septum (RV) lead implantation because of lead dislodgement ($n = 2$) or rise in pacing threshold ($n = 1$), while two (2.4%) patients required His lead repositioning because of lead dislodgement ($n = 1$) and phrenic nerve stimulation ($n = 1$). Nineteen patients (23.2%) experienced a significant rise in Hisian pacing threshold and 1 of these patients also had poor sensing parameters. Oversensing was noted in 8 (9.7%) patients and in 7 of them (87.5%) it was due to both atrioventricular and ventriculoatrial crosstalk events. As regards clinical outcomes, seven patients (8.5%) were diagnosed with new onset atrial fibrillation (AF), one of them complicated by stroke. Three patients (3.6%) were hospitalized for acute heart failure, one of them after His lead dislodgement. Finally, five patients (6.1%) died during follow-up, but no death was related to cardiovascular events.
Conclusions: HBP is an effective technique to obtain a more physiological cardiac pacing, but it is limited by a moderate rate of procedural failure and follow-up complications, mainly rising in pacing threshold and oversensing events. This is probably due to suboptimal implantation tools and lack of specific programming algorithms. New dedicated tools, increased experience, knowledge of device limitations, and optimal programming are needed to improve future outcomes.

444 Epidemiology of subclinical atrial fibrillation in patients with cardiac implantable electronic devices: a systematic review and meta-regression

Marco Borgi[1], Marco Proietti[2,3], Giulio Francesco Romiti[4], Marco Vitolo[5], Arianna Di Rocco[6], Alessio Farcomeni[7], Kazuo Miyazawa[8], Jeff S Healey[9], Deirdre Lane[10], Giuseppe Boriani[5], Stefania Basili[6], and Gregory Y. H Lip[10]
[1]Department of Clinical and Experimental Medicine, Policlinic 'G Martino' University of Messina, Messina, Italy, [2]Geriatric Unit, IRCCS Istituti Clinici Scientifici Maugeri, Milan, Italy, [3]Department of Clinical Sciences and Community Health, University of Milan, Milan, Italy, [4]Department of Translational and Precision Medicine, Sapienza University of Rome, Rome, Italy, [5]Cardiology Division, Department of Biomedical, Metabolic and Neural Sciences, University of Modena and Reggio Emilia, Policlinico di Modena, Modena, Italy, [6]Department of Public Health and Infectious Diseases, Spaienza University of Rome, Rome, Italy, [7]Department of Economics and Finance, University of Roma 'Tor Vergata', Rome, Italy, [8]Department of Cardiovascular Medicine, Chiba University Graduate School of Medicine, Chiba, Japan, [9]Division of Cardiology, Department of Medicine, McMaster University, Hamilton, ON, Canada, and [10]Liverpool Centre for Cardiovascular Science, University of Liverpool and Liverpool Heart & Chest Hospital, Liverpool, UK

Aims: In recent years, attention to subclinical atrial fibrillation (SCAF), defined as the presence of atrial high-rate episodes (AHREs), in patients with cardiac implantable electronic devices (CIEDs), has gained much interest as a determinant of clinical AF and stroke risk. To perform a systematic review and meta-regression of the available scientific evidence regarding the epidemiology of SCAF in patients receiving CIEDs.
Methods and results: PubMed and EMBASE were searched for all studies documenting the incidence of AHREs in patients ($n = 100$ or more) with CIEDs without any previous history of AF from inception to 20 August 2021, screened by two independent blind reviewers. This study was registered in PROSPERO: CRD42019106994. Among the 2614 results initially retrieved, 54 studies were included, with a total of 72 784 patients. Meta-analysis of included studies showed a pooled prevalence of SCAF of 28.1%, with an incidence rate (IR) of 16 new SCAF cases per 100 patient-years ($I^2 = 100\%$). Multivariate meta-regression analysis showed that age and follow-up time were the only significant determinants of IR, explaining a large part of the heterogeneity ($R^2 = 61.5\%$, $P < 0.001$), with higher IR at earlier follow-up and in older patients, decreasing over follow-up time and increasing according to mean age.

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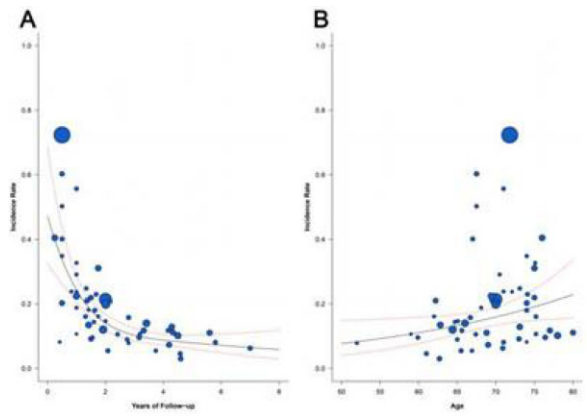
Older age, higher CHA_2DS_2-VASc score, history of AF, hypertension, CHF, and stroke/TIA were all associated with SCAF occurrence.
Conclusions: In this systematic review and meta-regression analysis, IR of SCAF increased with age and decreased over longer follow-up times. SCAF was associated with older age, higher thromboembolic risk, and several cardiovascular comorbidities.



444 Figure 1 Univariate meta-regression analysis for SCAF incidence rate. (*A*) Years of follow-up. (*B*) Age.

606 Predictive value of left atrial and left ventricular strain for the detection of atrial fibrillation in patients with cryptogenic stroke

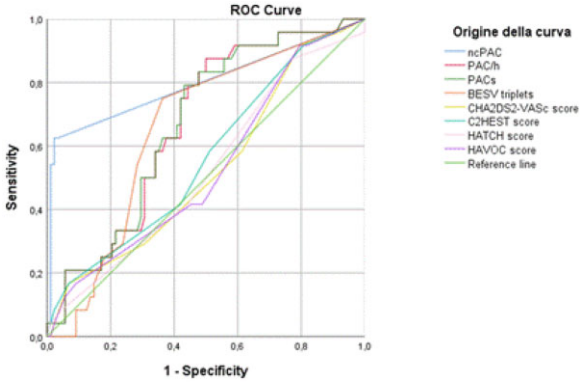
Gabriella Bufano[1], Francesco Radico[2,3], Carolina Maria D'Angelo[3], Francesca Pierfelice[1], Maria Vittoria De Angelis[4], Massimiliano Faustino[3], Sante Donato Pierdomenico[1], Sabina Gallina[2], and Giulia Renda[2]
[1]Department of Innovative Technologies in Medicine and Dentistry, 'G. D'Annunzio' University Chieti, Pescara, Italy, [2]Department of Neuroscience, Imaging and Clinical Sciences, 'G. D'Annunzio' University Chieti, Pescara, Italy, [3]Department of Cardiology, Renzetti Hospital, Lanciano, Italy, [4]Stroke Unit, Department of Neurology, SS Annunziata Hospital, Chieti, Italy, and [5]Department of Cardiology, SS Annunziata Hospital, Chieti, Italy

Aims: Cryptogenic stroke (CS) is associated with high rate of recurrences and adverse outcomes at long-term follow-up, especially in light of its unknown etiology that often leads to ineffective secondary prevention. In such scenario, asymptomatic misdiagnosed atrial fibrillation (AF) episodes could play an important pathophysiological role. Some studies have pointed left atrial (LA) and left ventricular (LV) systolic and diastolic dysfunction as surrogate markers of AF. The aim of this study was to evaluate the relationship between echocardiographic parameters of LA and LV function, and the occurrence of AF revealed by continuous electrocardiogram (ECG) monitoring in a cohort of CS patients.
Methods and results: This is a single-centre prospective cohort study. Seventy-two CS patients with continuous ECG monitoring with insertable cardiac monitor (ICM) underwent transthoracic echocardiography (TTE). TTE was focused on LA and LV function, including both standard and longitudinal strain-derived parameters. All detected AF episodes lasting more than 2 min were considered. Patients with and without AF were homogeneous in all baseline characteristics, except for CHA2DS2-VASc score, which was significantly higher in AF group, and prevalence of hypercholesterolaemia, that was significantly higher in no-AF group. ICM revealed AF in 23 patients (32%), on average 196 days after ICM implantation. Among echocardiographic parameters, LV ejection fraction (LVEF, $P = 0.007$), LA end systolic area (LAES area, $P = 0.006$), LA volume index (LAVI, $P = 0.008$), total LA emptying fraction (LATEF, $P = 0.013$), *E* velocity ($P = 0.042$), pulmonary veins AR duration ($P = 0.01$), septal and median TDI *E*/*e*′ (respectively, $P = 0.045$ and $P = 0.039$), peak atrial longitudinal strain (PALS) in 4-chamber and in 2-chamber view (respectively, $P < 0.001$ and $P = 0.011$), peak atrial contraction strain (PACS, $P < 0.001$), LA conduit strain ($P = 0.005$), and LV longitudinal strain (LVLS, $P = 0.001$) were significantly associated to the occurrence of AF, suggesting worst atrial function in AF group. Furthermore, multivariable regression analysis revealed that PACS and LV strain were the only echocardiographic parameters independently associated with AF [confidence interval (CI) 95%: 0.48–0.90, $P = 0.005$ and CI 95%: 0.46–0.95, $P = 0.041$ respectively].
Conclusions: In a cohort of CS patients, continuous ECG monitoring with ICM revealed subclinical AF episodes in about one-third of patients. In such population, LA and LV strain analysis add predictive value for occurrence of AF over clinical and morpho-functional echocardiographic parameters. Impaired booster pump strain and LVLS strain are strong and independent predictors of AF.

754 Non-conducted premature atrial complexes: a new predictor for atrial fibrillation in cryptogenic stroke patients

Giampaolo Vetta[1,2], Antonio Parlavecchio[1], Rodolfo Caminiti[1], Michele Magnocavallo[2], Carlo Lavalle[2], Domenico G. Della Rocca[2], Giovanni Marano[1], Chiara Ruggieri[1], Pasquale Crea[1], Giuseppe Dattilo[1], Ludovica Ferrau[3], Rosa Musolino[3], Concetta Zito[1], Francesco Luzza[1], Antonio Micari[1], Scipione Carerj[1], and Gianluca Di Bella[1]
[1]Cardiology Unit, Department of Clinical and Experimental Medicine, University Hospital of Messina, Italy, [2]Department of Cardiovascular, Respiratory, Nephrological, Anesthesiological and Geriatric Sciences, 'Sapienza' University of Rome, Policlinico Umberto I, Italy, and [3]Dipartimento di Neuroscienze, Scienze Psichiatriche e Anestesiologiche Clinica Neurologica, Università di Messina, Italy

Aims: Atrial fibrillation (AF) is the main cardiac cause of stroke, but it frequently remains undetected. In these patient monitoring for AF is recommended using a Holter electrocardiogram (ECG). The aim of the present study is to study non-conducted atrial complexes (ncPAC) recorded on Holter ECG as a new predictor of AF.
Methods and results: Patients admitted to the Stroke Unit of our hospital for cryptogenic stroke from December 2018 to January 2020 who underwent 24-h electrocardiographic monitoring were prospectively enrolled in the study and were subsequently submitted to 3-month and 6-month follow-up to investigate the occurrence of AF. The study recruited 112 patients. At follow-up visit, AF was diagnosed in 21.4% of the population. The only statistically significant difference between the group with and without a AF diagnosis was the presence of ncPAC (83.3% vs. 16.7%; $P < 0.0001$). ROC analysis was performed and showed that ncPAC had the best diagnostic accuracy in the AF diagnosis [AUC: 0.798; confidence interval (CI): 0.675–0.921]. The AUC of ncPAC was significantly better than the AUC of premature atrial complexes (PACs) ($P < 0.05$), CHA_2DS_2-VASc, HATCH, HAVOC, and C_2HEST scores ($P < 0.01$). Kaplan–Meier curve survival estimate for AF onset by the presence of ncPAC revealed that there was a significant difference in the AF onset between patients with ncPAC and those without ($P < 0.0001$) and multivariate Cox-proportional hazard analysis revealed that ncPAC presence was an independent predictors of AF onset [hazards ratio (HR): 9.28; CI 95%: 2,66–32,40; $P = 0.0001$].
Conclusions: The presence of ncPAC represents a new predictor of AF that could further guide the investigation of AF in patients with cryptogenic stroke.



703 Koch's triangle voltage mapping for cryoablation of slow pathway in children: preliminary data of a novel high density technique

Ilaria Cazzoli[1], Pietro Paolo Tamborrino[1], Luigina Porco[1], Marta Campisi[1], Veronica Fanti[2], Roberta Annibali[2], Massimo Stefano Silvetti[1], and Fabrizio Drago[1]
[1]Pediatric Cardiology and Cardiac Arrhythmia/Syncope Unit, Department of Pediatric Cardiology, Bambino Gesù Children's Hospital IRCCS, Italy, and [2]Abbott, St Jude Abbott Medical Italia, Sesto San Giovanni, Milan, Italy

Aims: Different authors have described three-dimensional (3D) voltage mapping of the Koch's triangle (KT) in order to find low-voltage bridges (LVBs) as targets for a successful transcatheter ablation (TCA) of the slow pathway (SP) in children. Recently, the advisor high density (HD) Grid™ mapping catheter was introduced as new multipolar catheter for HD mapping. The aim of the study was to describe our preliminary experience with the use of HD Grid™ catheter in LVB and electrophysiologically guided cryoablation of SP in children.
Methods and results: Twenty-one children (mean age 13 ± 3 years) with atrioventricular nodal re-entrant tachycardia (AVNRT) underwent cryoablation of SP guided by voltage HD mapping of the KT using HD Grid™ catheter. In order to better highlight the differences with conventional mapping, point collection was performed in each patient with this new multipolar catheter and with a quadripolar catheter. The conventional mapping collected 871 ± 262 points and used 211 ± 80 points in

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887 ± 275 s, whereas HD mapping collected 7468 ± 2947 points, using 604 ± 165 points in 513 ± 181 s ($P < 0.001$). Moreover, the LVB area mapped with HD Grid™ was about one-half smaller and clearly delineated. Cryoablation acute success rate was 100%. Overall median fluoroscopy exposure was 0.08 (0.01–5.42) μGy/m^2, with a median fluoroscopy time of 0.1 (0.0–0.6) min. During the follow-up (4.8 ± 3.7 months), there were no recurrences. No complications occurred.
Conclusions: Our preliminary experience shows that HD mapping is faster and offers higher spatial resolution and definition. Procedural time can be reduced maintaining the TCA safe, with reduced fluoroscopy use, and successful.

245 Arrhythmogenic cardiomyopathy in children according to 'padua criteria': single paediatric centre experience

Marianna Cicenia[1], Nicoletta Cantarutti[1], Rachele Adorisio[2], Massimo Stefano Silvetti[1], Aurelio Secinaro[3], Paolo Ciancarella[3], Corrado Di Mambro[1], Monia Magliozzi[4], Antonio Novelli[4], Antonio Amodeo[2], Anwar Baban[1], and Fabrizio Drago[1]
[1]Pediatric Cardiology and Arrhythmia/Syncope Complex Unit, Bambino Gesù Children Hospital, IRCCS, Rome, Italy, [2]Heart Failure and Transplant, Mechanical Circulatory Support Complex Unit, Bambino Gesù Children Hospital, IRCCS, Rome, Italy, [3]Advanced Cardiothoracic Imaging Unit, Bambino Gesù Children Hospital, IRCCS, Rome, Italy, and [4]Laboratiry of Medical Genetics, Bambino Gesù Children Hospital, IRCCS, Rome, Italy

Aims: Arrhythmogenic cardiomyopathy (ACM) is a rare disease in children. The purpose of this study is to describe the main features of our paediatric patients with ACM providing a contribution for diagnostic work-up and therapeutic decisions.
Methods and results: Eligibility criteria of the study was ACM diagnosed at age <18 years old. We enrolled 21 patients (mean age at diagnosis 13.9 ± 2 years). Holter monitoring showed premature ventricular complexes (PVCs) burden of 7.9 ± 10% (range: 1–35%). Exercise testing showed suppression of PVCs during exercise in most patients (44.4%). Cardiac magnetic resonance was performed in 17/21 (81%) patients. Right ventricular (RV) dilatation, segmental wall motion abnormalities, and late gadolinium enhancement of both ventricles were the predominant features. Genetic results were available in 19/21 patients. 3/19 (15.8%) had compound heterozygous variants, 3/19 (15.8%) digenic variants, and 6/19 (31.6%) a single variant. EPS was performed in 15/21 (75%). Ventricular tachycardia was inducible in 3/15 (20%) and ventricular fibrillation occurred in 1/15 (6.7%). Implantable cardiac defibrillators (ICDs) were implanted in 15 patients (71.4%). ICD therapies were released in two patients during follow-up (2009–2021). No patients died suddenly.
Conclusions: Paediatric ACM can be diagnosed in the majority of cases secondary to: incidental finding of minor arrhythmias or due to positive family history. PVCs burden is not elevated and exercise-induced arrhythmias occur in a minority of patients. ICD may be indicated in most patients even if follow-up during the paediatric age can be reassuring. Multicentric observation is highly needed to derive conclusions in children.

217 Why it is important to recognize Brugada syndrome in athletes: a case report

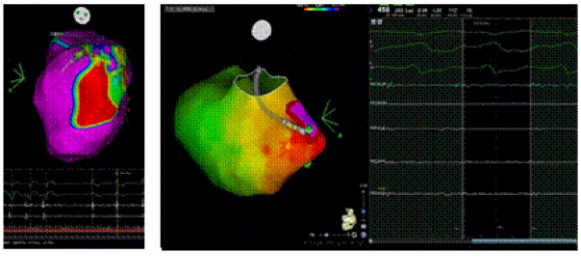
Lidia Colangelo[1], Maria Colangelo[2], and Luca Stefanini[1]
[1]Juventus Medical Centre, Italy, and [2]Ospedale Giovanni Paolo II di Lamezia Terme, Italy

Aims: The Brugada syndrome (Brs) is an inherited disorder associated with risk of ventricular fibrillation and sudden cardiac death in a structurally normal heart. The purpose of this case presentation was to spread awareness about this condition, highlight the importance of timely diagnosis and effective treatment of this channelopathy especially in asymptomatic young athletes at high risk of sudden cardiac death.
Methods and results: In this report, we discuss the case of a 47-year-old male. He was a tennis player who performed a visit to the sports doctor to have issued a certificate for competitive fitness. He had no familiar history of sudden death or syncope. The patient's electrocardiogram (ECG) revealed J-point elevation and ST-segment elevation in the right precordial leads V1 and V2 positioned in the second, third, or fourth intercostal space, showing classic type II 'saddleback' morphology in V2 and BrS was suspected. Hence, the patient underwent Holter ECG monitoring with evidence of spontaneous type 1 Brugada pattern ('coved' morphology), as well as frequent ventricular ectopic beats with left branch block morphology. Indeed, a diagnosis of BrS was made. Antiarrhythmic prophylaxis therapy with hydroquinidine was initiated and the patient was suspended from competitive activity with a 3-month follow-up.
Conclusions: The BrS is a hereditary disease characterized by a typical ECG pattern potentially predisposing active individuals with no patent structural heart disease to ventricular arrhythmias (VA) and sudden cardiac death (SCD). Nowadays, it is difficult to discern the true burden of BrS due to the unknown real prevalence of asymptomatic patients and the dynamic variability of the ECG pattern in individuals. The purpose of this case presentation was to spread awareness about this condition, highlight the importance of timely diagnosis, and effective treatment of this channelopathy especially in asymptomatic young athletes at high risk of SCD. Indeed, exercise may potentially worsen the ECG abnormalities in BrS patients, resulting in higher peak J-point amplitudes during the vasovagal reaction of the recovery period, possibly leading to an increased risk of cardiac events. Moreover, the enhanced vagal tone in athletes could be both a BrS risk factor and an exercise effect. For this reason, athletic preparticipation screening is essential for minimizing the risk for SCD in athletes participating in either competitive or leisure sporting activities.

671 First-in-man mapping and ablation of ventricular tachycardia using a novel ablation catheter with microelectrodes and thermocouples

Paolo Compagnucci[1,2], Laura Cipolletta[2], Giovanni Volpato[1,2], Quintino Parisi[2], Enrico Rita[2], Silvano Molini[2], Agostino Misiani[2], Yari Valeri[1,2], Giulia Stronati[1,2], Federico Guerra[1,2], Michela Casella[2,3], and Antonio Dello Russo[1,2]
[1]Department of Biomedical Sciences and Public Health, Marche Polytechnic University, Ancona, Italy, [2]Cardiology and Arrhythmology Clinic, University Hospital 'Ospedali Riuniti', Ancona, Italy, and [3]Department of Clinical, Special and Dental Sciences, Marche Polytechnic University, Ancona, Italy

Aims: Catheter ablation (CA) is an important therapeutic option for patients with recurrent ventricular tachycardia (VT). Recently, a novel contact-force sensing catheter (QDOT, Biosense Webster) allowing radiofrequency ablation in a temperature-controlled fashion, equipped with microelectrodes and thermocouples has been developed and tested in very-high power short duration CA of atrial fibrillation. As of today, this catheter has never been used for VT ablation. To describe the safety and short-term clinical performance of the novel QDOT catheter for the ablation of recurrent VT/electrical storm.
Methods and results: Case 1: a 43-year-old male patient with prior anterior myocardial infarction (MI), left ventricular (LV) dysfunction with an apical aneurysm, and recurrent VT episodes was admitted to our hospital for CA of VT. The patient underwent high-density electroanatomical mapping of the left ventricle using a multipolar catheter (PentaRay, Biosense Webster), which showed an extensive apical dense scar region, corresponding to the ventricular aneurysm. When the QDOT catheter was advanced in that region, late/fragmented potentials were detected by microelectrodes as well as by conventional electrodes. During the procedure, a sustained VT with right bundle branch block (RBBB)-inferior axis morphology and transition in V2 could be induced. We recorder diastolic fragmented potentials inside the aneurysm, where the novel catheter previously showed late/fragmented potentials; radiofrequency energy delivery with conventional settings (40 W) in that area led to rapid arrhythmia termination (Figure A). At the end of the procedure, VTs were no more inducible. Case 2: a 79-year-old male patient with prior inferior MI, mild LV dysfunction with a 5 cm × 5 cm × 3 cm aneurysm of the basal-mid inferior wall, and two previous CAs for recurrent VT presented to our hospital for electrical storm due to multiple episodes of slow VT (cycle, 470 ms, RBBB morphology, inferior axis, transition in V6), which were refractory to antiarrhythmic drug treatment. We decided to perform redo CA using the QDOT catheter, which revealed long and fragmented low-amplitude diastolic potentials inside the LV aneurysm (Figure B). VT was rapidly terminated by means of radiofrequency energy delivery with usual settings (40 W) in this region, and was no more inducible afterwards.
Conclusions: The novel ablation catheter showed favourable manoeuverability in the ventricle, while also allowing a precise characterization of the tachycardia circuitry and of the arrhythmogenic myocardial substrate, which was enhanced by the availability of microelectrodes. We believe that this preliminary experience may pave the way for further assessments of this new technology in the so far unexplored ventricular milieu.



76 Right mini-thoracotomy surgical Cox-maze (left atrial lesion) vs. catheter ablation using contact force-sensing technology in patients with persistent atrial fibrillation

Gabriele D'Ambrosio[1,2], Santi Raffa[1], Silvio Romano[2], Obaida Alothman[1], Georgi Borisov[1], Issa Karam[1], Kuntze Thomas[1], and J. Christoph Geller[1,3]
[1]Zentralklinik, Bad Berka, Germany, [2]University of L'Aquila, Italy, and [3]Otto-Von-Guericke University School of Medicine, Magdeburg, Germany

Aims: Pulmonary vein isolation (PVI) often is not sufficient in patients (pts) with persistent atrial fibrillation (AF). Substrate modification (SM) by catheter ablation (CA)

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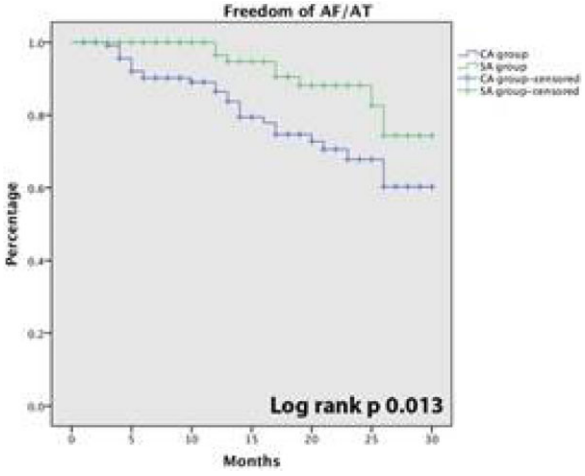
of low-voltage zones (LVZ) has yielded favourable results, but those studies were performed before the introduction of contact force (CF) sensing technology. Surgical ablation (SA) studies support the hypothesis that empiric bi-atrial linear ablation (Cox Maze IV procedure) is able to improve success, but there is less data on outcome of patients undergoing left atrial (LA) linear lesions alone. In current guidelines, both CA and SA have Class IIa indication in pts with persistent AF. In this single-centre retrospective study, we analysed the long-term outcomes of CA and SA in pts with persistent AF.

Methods and results: In the CA group (Figure 1), pts underwent PVI and additional SM in the presence of LVZ (roof line and supero-septal line) using TactiCath™ or SmartTouch™ ablation catheters aiming at contact values $\geq 10\,g < 20\,g$ and FTI $>400\,g/s$. Ablation was performed in a temperature-controlled fashion with energy of 30 W except at the posterior wall (20–25 W). In the SA group (Figure 2), pts underwent ablation procedure (creation of a pure LA endocardial lesion set consistent with the Cox Maze IV) performed by a right mini-thoracotomy approach using the Atricure™ cryoablation probe, a left atrial appendage (LAA) epicardial exclusion using the Atriclip™ system, and mitral valve repair in the presence of severe mitral valve regurgitation. No right atrial lesions were created. 196 pts were included. 120 pts underwent CA [median age: 65 (58–72) years, median LA volume index (LAVI): 66 (56–75) ml/m^2], in pts with LVZs PVI + SM was performed [bidirectional block of lines in 100%]. 76 pts underwent SA [median age: 64 (58–74) years, median LAVI 90 (78–103) ml/m^2], in 42 pts a mitral valve repair was performed. At 24 months (figure), 89% and 68% of pts were free of AF in the SA and CA group, respectively, mainly without antiarrhythmic drugs (92% SA group and 89% CA group).

Conclusions: In patients with persistent AF, SA performed by a right mini-thoracotomy approach with linear lesions limited to LA leads to excellent 2-year freedom from AF despite significantly larger LAVI compared with the CA group. LAA epicardial exclusion likely contributed to surgical efficacy by eliminating the LAA as trigger/driver.



409 Not all ST elevation are myocardial infarction: a lesson learned from 'spiked helmet sign'

Guido Del Monaco[1,2], Sara Bombace[1,2], and Antonio Taormina[1,2]
[1]Humanitas Research Hospital IRCCS, Rozzano, Milano, Italy, and [2]Cardio Center IRCCS Humanitas Research Hospital, Rozzano, Milano, Italy

Aims: ST segment elevation is an electrocardiogram (ECG) finding first of all suggestive of acute coronary syndrome (ACS). However, there are other causes of ST segment elevation that seem to not have any relationship with coronary artery disease (CAD). One of these is the so-called 'Spiked Helmet Sign' (SHS), an ECG pattern characterized by upslope of ST segment before R wave onset that is reported to be found in critical illness and is associated with negative outcomes.

Methods and results: A 14-years-old boy came comatose (Glasgow Coma Scale = 4) to the Emergency Room after being run over by a car. He was immediately intubated and mechanically ventilated. Baseline ECG was reported to be normal, showing an incomplete right bundle branch block and a slightly prolonged QTc interval. CT-scan showed subarachnoid haemorrhage and multiple skull fractures requiring decompressive craniectomy. During hospitalization the patient developed marked hypotension complicated by rise of inflammation indexes and 12 lead ECG revealed new-onset of diffuse ST-segment elevation with spike-and-dome appearance mainly in lateral precordial leads, while lead II and V2 didn't show any ST-segment alteration. Transthoracic echocardiogram was reported to be normal. Due to critical conditions and low likelihood of CAD, angiography wasn't performed. The clinical course was worsened by occurrence of hyperkalaemia, acute kidney injury, and multiple episodes of ventricular tachycardia evolving in pulselessness electrical activity which required advanced life support. The patient subsequently died due to multi-organ failure, without the possibility of escalation therapy due to his status. SHS is an emerging ECG sign that is reported to be associated with critical conditions (mechanical ventilation, sepsis, bowel perforation) and in the majority of cases it is not related to CAD. It usually occurs in inferior leads (especially in case of abdominal disease) and in precordial leads (pneumothorax, aortic dissection, mechanical ventilation). Our patient had features consistent with previous cases reported in literature and, even if he experienced several episodes of cardiac arrest and blood exams revealed elevated values of cardiac troponin, the typical ECG pattern and the normal echocardiogram suggest SHS instead of ACS, avoiding unnecessary percutaneous coronary intervention. As reported in literature, even if in our case the appearance of this sign was associated with poor prognosis.

Conclusions: SHS mainly occurs in critically ill patients and is associated with death and poor outcomes. The potential pathophysiological mechanisms are still unclear. It is important to promptly recognize this pattern and differentiate between other causes of ST-segment elevation to select the appropriate therapy according to the setting. This is the first case-report among Italian hospitals of SHS.

605 Assessment of intracardiac flow dynamics for the evaluation of patients with cardiac resynchronization therapy

Jessica Ielapi[1], Antonio Curcio[1], Giovanna Marrelli[1], Antonio Strangio[1], Isabella Leo[1], Giuseppe Panuccio[1], Iolanda Aquila[1], Simona De Luca[1], Giuseppe Santarpia[1], and Ciro Indolfi[1,2]
[1]Division of cardiology, Department of Medical and Surgical Sciences, Magna Graecia University, Catanzaro, Italy, and [2]Mediterranea Cardiocentro, Naples, Italy

Aims: Cardiac resynchronization therapy (CRT) is an established treatment for patients with heart failure (HF), reduced left ventricular ejection fraction (EF $\leq$ 35%) and high-grade intraventricular conduction delays. CRT improves cardiac function, symptoms and well-being, and reduces morbidity and mortality in this setting. However, there are patients unresponsive to CRT. Responders show reverse ventricular remodelling, volumes and diameters reduction, and EF improvement. Noninvasive cardiovascular imaging for visualization and quantitation of intracardiac flows and turbulences has not been assessed thoroughly in CRT. This study seeks to evaluate if the quantitative analysis of intracardiac flow dynamics in HF patients treated by CRT might provide additional information for device optimization and clinical response.

Methods and results: Fifteen HF patients (five females, age 69.6 $\pm$ 9.4 years, NYHA class II/III, EF 29.3 $\pm$ 4.6%) were enrolled in the study. Eleven had primitive dilated cardiomyopathy and four had post-ischaemic etiology with completed revascularization. Pacemaker-dependent cases were excluded. MyLab™ X8 platform was used for echocardiographic assessment of intracardiac flow dynamics performed on apical three chamber views. All examinations were realized in baseline (active CRT) and after 5 min of biventricular pacing switch off. The hyperDoppler software was used to assess intracardiac vortexes properties. The analyzed parameters were: vortex area, vortex length, vortex depth, and kinetic of energy dissipation (ΔKE). Categorical variables are expressed as numbers and percentages. Quantitative variables are expressed as mean and standard deviation (SD). Shapiro–Wilk test, D'Agostino Pearson test, and visual inspection of Q-Q-plots were executed to evaluate if variables were normally distributed. Quantitative variables were evaluated with paired sample *T*-test or Wilcoxon test when appropriate. Clinical features, biochemical parameters, electrocardiograms with and without cardiac pacing, and EF before and after CRT implantation were collected. Although no difference was observed in vortex area/depth/length, a significant increase in KE dissipation after switching OFF the CRT devices (from 1.2 $\pm$ 0.9 to 3.5 $\pm$ 2.3 J, $P < 0.03$) was remarkably observed. According to EF improvement after CRT, the patients were divided in responders (5% increase in EF, $N = 10$) and non-responders ($N = 5$). Moreover, by analysing the extent of QRS dispersion and the variation of KE dissipation in spontaneous rhythm and after silencing the biventricular pacing, a positive ventricular remodelling (QRS 141.3 $\pm$ 29.3 vs. 154.4 $\pm$ 24.4ms, $P = 0.02$; KE dissipation 0.92 $\pm$ 0.87 J in responders and 1.53 $\pm$ 1.76 J in non-responders, $P = 0.006$) was detected in responders.

Conclusions: Noninvasive intracardiac flow dynamics in HF patients represents a complementary tool to standard echocardiography, and provides additional parameters for assessing prognosis and outcomes in CRT recipients. The impact of maladaptation in intracardiac flow dynamic on progressive LV remodelling could be useful to evaluate the prognostic meaning of implanted CRT device and to predict the response to device implantation, based on cardiac flow analysis.

769 Differential pharmacological modulation of arrhythmic phenotype in catecholaminergic polymorphic ventricular tachycardia: not all betablockers are the same

Deni Kukavica[1,2,3], Andrea Mazzanti[1,2,3], Alessandro Trancuccio[1,2,3], Gala Giannini[1,2], Maira Marino[1], Muhammad Mohsin[1], Raffaella Bloise[1], Carlo Napolitano[1,2], and Silvia G Priori[1,2,3]
[1]Molecular Cardiology, IRCCS ICS Maugeri, Pavia, Italy, [2]Department of Molecular Medicine, University of Pavia, Italy, and [3]Centro Nacional de Investigaciones Cardiovasculares Carlos III, Madrid, Spain

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Aims: Catecholaminergic polymorphic ventricular tachycardia (CPVT) is an inherited arrhythmogenic disorder that predisposes patients to develop catecholamine-mediated ventricular arrhythmias (VA), manifesting as exercise- or emotion-induced syncope or cardiac arrest. Due to the catecholaminergic nature of CPVT, exercise stress test (EST) represents the most important diagnostic test. Although widely used in clinical practice to monitor response to therapy, how BBs modulate the occurrence of ventricular arrhythmias during EST in CPVT patients is unclear. To compare the relative efficacy of different classes of *betablockers* (BBs, β1-selective BBs vs. nadolol) on the arrhythmic manifestations during ESTs performed off-therapy and on-therapy in patients with CPVT.

Methods and results: We selected 72 patients (45 females) with pathogenic or likely pathogenic variants on *RYR2* or *CASQ2* from our cohort of 246 genotype-positive CPVT patients, who had at least one EST off-therapy and at least one EST during BB therapy. Overall, 507 ESTs (77 ESTs off-therapy, 29 ESTs during β1-selective BBs, and 401 during nadolol) were prospectively collected over 11.1 ± 6.8 years of follow-up and analysed, with a median of 5 ESTs per patient [interquartile range (IQR): 3–10 ESTs, range: 2–27 ESTs]. In the absence of therapy, VT was documented in 46/77 (60%) cases. BB therapy with nadolol significantly reduced VT at EST to 10% (41/398; $P < 0.001$). Conversely, β1-selective BBs did not significantly decrease VT incidence at EST (13/29, 45%, $P = 0.289$) as compared to baseline. Importantly, nadolol was superior in preventing VT both when compared to off-therapy [odds ratio (OR): 33.9, 95% confidence interval (CI): 15.6–73.5, $P < 0.001$] but also when compared to β1-selective BBs [OR: 18.0, 95% CI: 6.0–53.5, $P < 0.001$]. Although β1-selective BBs significantly increased the total exercise time free of arrhythmias (median 248 s, IQR: 212–315 s) as compared to baseline (median 83 s, IQR: 12–207 s; $P < 0.001$), arrhythmia-free exercise time during nadolol (median 381 s, IQR: 251–543 s) was significantly longer as compared to both off-therapy ($P < 0.001$) and β1-selective BBs ($P = 0.020$). Multivariate mixed effects logistic regression confirmed that at parity of time of occurrence of first arrhythmia and percentage of maximal heart rate reached, both of which were significantly associated to VT occurrence ($P = 0.001$ for both), the use of nadolol (OR: 0.23; 95% CI: 0.09–0.60; $P = 0.011$) was independently associated with decreased incidence of VT. Focusing on the 14 patients (overall 133 ESTs) who had at least one ESTs after the occurrence of VT in nadolol, we dissected the effect of dose increase on the probability of VT reoccurrence. Following the documentation of breakthrough VT, increasing the dose of nadolol by 0.5 mg/kg reduced by 2.5 times the probability of having a recurrence of VT (OR: −2.49, 95% CI: −3.96 to −1.0; $P < 0.001$).

Conclusions: Once CPVT is diagnosed, nadolol at 1 mg/kg/day should be used as preferred therapy as it has been shown to suppress VT in most patients. In rare instances in which VA persist despite an adequate nadolol dose, dose increase to 1.5 mg/kg/day may represent an efficacious antiarrhythmic strategy.

480 Catheter pulmonary vein ablation vs. medical therapy or atrioventricular node ablation and resynchronization in patients with atrial fibrillation and heart failure: a systematic review and meta-analysis

Gaetano Liccardo[1,2], Francesco Cannata[1,2], Mauro Chiarito[1,2], Sara Bombace[1,2], Marta Maccallini[1,2], Alessandro Villaschi[1,2], Giuseppe Pinto[1,2], Fabio Fazzari[2], Daniela Pini[2], Renato Maria Bragato[2], Gianluigi Condorelli[1,2], Riccardo Cappato[1,3], and Giulio G Stefanini[1,2]

[1]Department of Biomedical Sciences, Humanitas University, Pieve Emanuele, Milan, Italy, [2]IRCCS Humanitas Research Hospital, Rozzano, Milan, Italy, and [3]Arrhythmia and Clinical Electrophysiology Center, IRCCS, Multimedica Group, Sesto San Giovanni, Milan, Italy

Aims: Atrial fibrillation (AF) and heart failure (HF) are increasing in prevalence worldwide and, when present altogether, are associated with significant mortality and morbidity. Several and recent randomized clinical trials have reported an improvement of clinical outcomes in patients with HF and AF with catheter ablation. To provide a comprehensive and updated synthesis of effect estimates of the available randomized and observational clinical trials comparing pulmonary vein isolation with optimal medical therapy (rate or rhythm) or atrioventricular node ablation and resynchronization.

Methods and results: MEDLINE database was searched from inception to 4 March 2021 by two reviewers (F.C. and M.C.) for relevant studies. The following key words were used: 'atrial fibrillation', 'heart failure', 'ablation', 'medical', 'drug', 'rate', 'rhythm', 'resynchronization', and 'atrial flutter'. The co-primary outcomes were all-cause death and hospitalization for HF. A total of 16 studies enrolling 42 908 patients were included; of these, 9 were randomized controlled trials, 3 unadjusted observational studies, and 4 adjusted observational trials. Patients treated with catheter ablation had a statistically significant reduction for the risk of all-cause death {Figure on the left: odds ratio [OR]: 0.51, [95% confidence interval (CI): 0.31–0.84], $P = 0.008$, NNT 33} and hospitalization for HF [Figure on the right: OR: 0.52, (95% CI: 0.31–0.87), P 0.014, NNT 24]. Subgroup analysis confirmed these results only in HF with reduced ejection fraction subgroup. Meta-regression analyses showed a direct correlation between a higher burden of persistent/long-standing persistent AF and the positive impact of catheter ablation of AF. Moreover, the age of 70 years emerged as the cut-off age for a greater impact of catheter ablation.

Conclusions: Catheter ablation of AF is associated with a lower risk of all-cause death and HF hospitalizations in patients with AF and HF, as compared to medical therapy or atrioventricular node ablation and resynchronization. These results are mainly applicable for HF with reduced ejection fraction.

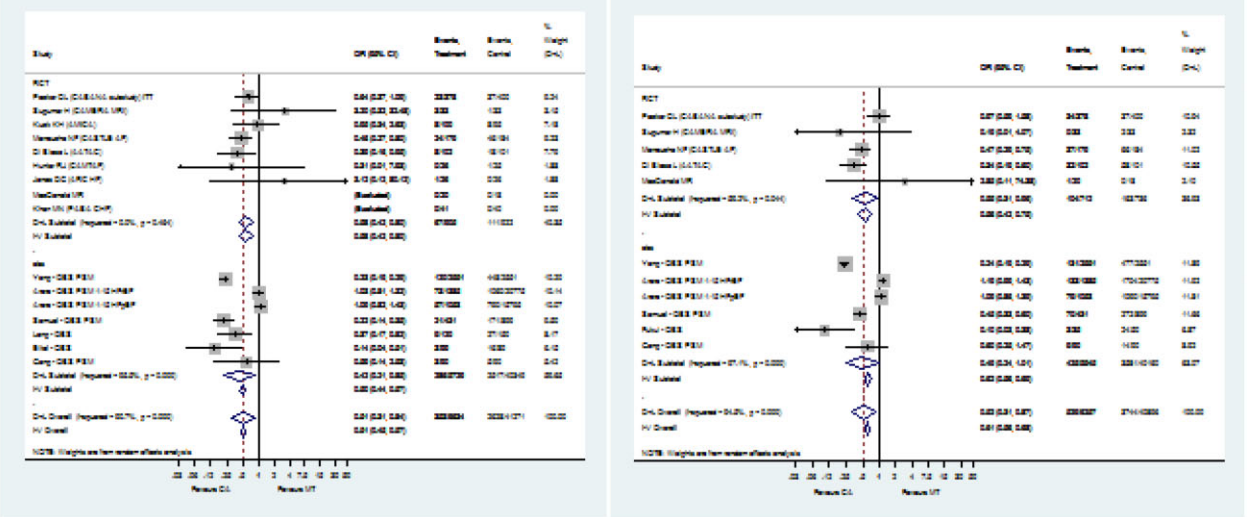
564 Controversial role of intracardiac eletrophysiology study in Brugada syndrome: analysis of a single-centre retrospective cohort study

Claudio Licciardello, Jacopo Marazzato, Michele Golino, Francesca Seganfreddo, Federica Matteo, Fulvio Lorenzo Francesco Giovenzana, Cinzia Franzosi, Paola Genoni, and Roberto De Ponti

Department of Medicine and Surgery, University of Insubria, Varese, Italy

Aims: According to European guidelines, aborted sudden cardiac death (SCD) in Brugada syndrome (BrS) is regarded as a I class recommendation for secondary prevention implantable cardioverter defibrillator (ICD). However, the risk stratification of BrS patients for primary prevention ICD still represents a clinical conundrum. Although intracardiac electrophysiology (EP) study proved useful for the selection of high-risk patients in this setting. Therefore, aim of this study was to assess all clinical and EP variables associated with the induction of VA at EP study and the rate of appropriate/inappropriate ICD interventions and/or clinical SCD events in these patients occurring at follow-up.

Methods and results: From 2001 to 2021, all EP studies performed in symptomatic/asymptomatic patients (46 ± 14 years, M 88%) with/without family history of SCD spontaneous/drug-induced type I pattern (TIP) on ECG and no spontaneous



480 Figure 1

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ventricular arrhythmias were retrospectively considered at our study centre. Clinical variables, BrS pattern, EP study data (including right ventricular site and type of stimulation protocol), and ICD interventions (DC-shocks or Anti-Tachycardia Pacing events, ATP) and/or SCD events occurring at follow-up were all evaluated. EP study was deemed positive for any polymorphic VA induced during programmed ventricular stimulation; non-sustained episodes included. ICD was routinely implanted in all patients with a positive EP study. Follow-up data were detected by the collection of medical and home-monitoring recordings at study-site level. Follow-up data were available in 50 patients (9 ± 6 years on average). Patients were generally young with few cardiovascular comorbidities. SCD history was known in 21 (42%) with a significant number of asymptomatic patients (48%). Br patterns were equally distributed in the investigated population (spontaneous and drug-induced TIP in 52% and 48%, respectively) and AF history was fairly common (16%). In the study population, EP study tested positive in 30 patients (60%): spontaneous TIP ($P = 0.0518$), few extrastimuli during programmed ventricular stimulation ($P = 0.0015$), and right ventricular stimulation at the apical site ($P \leq 0.0001$) were the only variables to be clearly associated with a positive EP study in the appraised patients. At follow-up, appropriate ICD shocks were documented in 4 out of 30 implanted patients (13%) at generally 5 ± 7 years from EP study evaluation. Although three ICD interventions (75%) occurred in patients with spontaneous TIP, one patient with drug-induced TIP pattern and positive EP study referred to Emergency Department for unrelenting VT storm after roughly 13 years from ICD implantation. Inappropriate ICD interventions for fast rate AF were detected in 10% of cases. Finally, no SCD events were documented at follow up in patients with a negative EP study.

Conclusions: In a retrospective analysis, EP study proved useful in the risk stratification of SCD in BrS patients. A few ventricular extrastimuli delivered at the right ventricular apex seem sufficient to prompt the induction of life-threatening VA in high-risk BrS patients during EP study. Moreover, in this setting, a negative EP study seems protective against the development of VA/SCD events at follow-up. However, not only is spontaneous TIP associated with an increased risk of arrhythmic death, but a drug-induced TIP, generally regarded as a low-risk condition, might also be associated with a long-term hazard of SCD in these patients.

640 Cannabis abuse and syncope

Marco Licciardi, Elena Utzeri, Maria Francesca Marchetti, Roberta Pittau, Nicola Campana, Elena Orani, Vincenzo Nissardi, Roberta Demelas, Silvia Maiani, Luigi Meloni, and Roberta Montisci
Clinical Cardiology Unit, AOU of Cagliari, Department of Medical Sciences and Public Health, University of Cagliari, Italy

Aims: Cannabis (marijuana) is the most consumed drug worldwide, counting roughly 200 million users in 2019 (4% of the global population). Once illegal in most of the world countries, cannabis is now legal for medical and recreational use in several states. During the last 20 years, we have observed a growing decriminalization wave parallel with an increase number of consumers: it is therefore mandatory not only for the cardiologists but for every physician to be aware of marijuana potential cardiovascular adverse health effects. With this paper, we present a case report of cannabis induced 16 s implantable loop recorder (ILR) recorded asystole from hypervagotonia in a 24-year-old heavy marijuana consumer. We focus on the infrequently reported association between syncope and chronic marijuana use and we try to explain the underlying mechanisms against the background of the current literature.

Methods and results: A 24-year-old presented to the emergency department sent by her cardiologist because of a recent finding of a 16 s asystole on the ILR she implanted 7 months before for recurrent syncopes. She openly declared that she is a heavy marijuana user (at least 5 cannabis-cigarette per day, not mixed up with tobacco, for no less than 12 years). She had a history of at least two spontaneous atypical syncopal episodes and a multitude of pre-syncopal episodes. Before being hospitalized, she underwent several diagnostic tests excluding a neurological etiology and, upon outpatient regimen, she begun a cardiology evaluation which lead to the ILR implantation. While watching TV at late night, the second prodrome-less syncopal episode occurred and a 16-s asystole was found on the ILR. During hospitalization, the patient was closely monitored and we evaluated basic autonomic function tests, carotid sinus massage, echocardiography, exercise stress test, and 24 h telemetry. Following the results of the exams, we considered a heart conduction system anomaly unlikely. Finally, the patient underwent a toxicological and a psychiatric evaluation, where she strongly expressed not wanting to abandon cannabis abuse. After a collective discussion with the heart team, syncope unit, electrophysiologists, and toxicologist, we decided to implant a dual chamber pacemaker with a rate response algorithm due to the high risk of trauma of the syncopal episodes.

Conclusions: Cannabis cardiovascular effects are not well known; among these we find ischaemic episodes, tachyarrhythmias, symptomatic sinus bradycardia, sinus arrest, and ventricular asystole. In the light of the poor literature, we believe that cannabis may produce opposite adverse effects depending on the duration of the habit. Acute administration increases sympathetic tone and reduces parasympathetic tone; conversely, with chronic intake an opposite effect is observed: repetitive dosing decreases sympathetic activity and increases parasympathetic activity. Physicians should be aware of the effects that cannabis produces upon the cardiovascular system: this could avoid expensive, prolonged hospitalizations, and needless diagnostic tests.

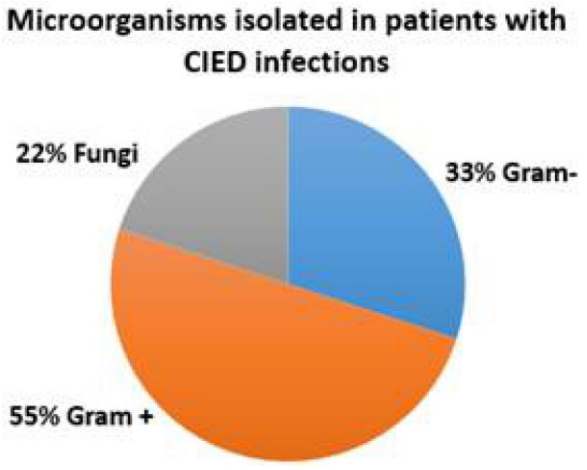
598 Are risk scores sufficient to stratify patients undergoing lead extraction? A single-centre analysis

Cinzia Mancuso[1], Antonio Curcio[1], Angelo Lamberti[2], Giuseppe Santarpia[1], Angela Quirino[2], Antonella Franzese[1], Enrico Maria Trecarichi[3], Carlo Torti[3], Gianni Matera[2], and Ciro Indolfi[1,4]
[1]Division of Cardiology, Department of Medical and Surgical Sciences, Magna Graecia University, Catanzaro, Italy, [2]Unit of Clinical Microbiology, Department of Health Sciences, Magna Graecia University, Catanzaro, Italy, [3]Infectious and Tropical Disease Unit, Department of Medical and Surgical Sciences, Magna Graecia University, Catanzaro, Italy, and [4]Mediterranea Cardiocentro, Naples, Italy

Aims: Device implantation is growing exponentially, as well as associated infections, ranging from isolated pocket erosion to endocarditis and bacteraemia, all worsening the prognosis of patients with frailty and comorbidity. Transvenous lead extraction (TLE) can resolve the complications, although a 1-year mortality risk of up to 25% is reported; despite higher health costs, prolonged hospitalization, and poor quality of life, strategies for predicting increased infection risk and reduced infection incidence are yet missing. Currently applied clinical scores do not consider etiologic microbial agents. We aimed to assess whether PADIT and UPCM scores could be implemented when bacteria or fungi are known to be causative of infection, and how these agents affected the outcome.

Methods and results: A retrospective analysis of patients undergone cardiac implantable electronic device (CIED) pocket revision, and/or TLE between 2016 and 2021 was performed. For each procedure, microbiological samples of both generator pocket tissue and intracardiac portions of the leads were analysed. In addition, blood cultures were performed in three sets. Transesophageal echocardiography was performed in all cases for ruling out suspected endocarditis. Spearman ad Pearson coefficients were tested for correlation among microorganism, prior infection and/or procedure, PADIT and UPCM scores; a *P*-value less than 0.05 was considered significant. We analysed 14 patients (10 males, 4 females, mean age $\pm$ SD: 72 ± 13): one case (4%) affected by pocket erosion, seven cases (50%) affected by both pocket site and lead infection (with associated bacteraemia in one subject), and one case (4%) due to lead-related infective endocarditis. Of these, five (36%) underwent device replacement, while nine (64%) to extraction or pocket/lead revision. Nine (64%) patients had positive culture examinations (Figure 1). The correlation method gave a statistically significant association between Gram$^-$ infection and prior sepsis (r 0.63; *P*-value 0.02). We considered the number of procedures on the same pocket and/or CIED previous infections as markers of frailty and increased infectious risk. As expected, the PADIT score, but not UPCM, significantly correlated with the number of previous procedures (r 0.70; *P*-value 0.006). Indeed, both scores had a similar infectious risk prediction.

Conclusions: In our analysis, predictive PADIT score of infectious risk performed better than UPCM, while both proved their reliability in identifying high-risk patients. The absence of correlation between UPCM score and infective agents is not conclusive, but probably due to the small sample size. Interestingly, growing rate of device reinfection correlates with the risk of Gram$^-$ bacterial infection. Thus, the integration of the microbiological data in the current prediction models could significantly increase their performance.



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512 Long-term survival in patients with post-operative atrial fibrillation after cardiac surgery: analysis from a prospective-cohort study

Jacopo Marazzato[1], Roberto De Ponti[1], Paolo Verdecchia[2], Federico Blasi[1], Michele Golino[1], Sandro Ferrarese[1], and Fabio Angeli[1,3]
[1]Department of Medicine and Surgery, University of Insubria, Varese, Italy, [2]Fondazione Umbra Cuore e Ipertensione—ONLUS and Division of Cardiology, Hospital S. Maria della Misericordia, Perugia, Italy, and [3]Department of Medicine and Cardiopulmonary Rehabilitation, Maugeri Care and Research Institute, IRCCS, Tradate, Italy

Aims: Post-operative atrial fibrillation (POP AF) is frequent in patients who undergo cardiac surgery. However, its prognostic impact in the long-term remains unclear.
Methods and results: We followed for an average of 10 ± 3 years 1386 patients who underwent a variety of cardiac surgical procedures (cardiac transplantation and surgery for heart failure included) while they were in sinus rhythm. Among 1178 patents without a history of AF, 726 (62%) did not develop AF during the entire duration of the study and 452 (38%) developed new-onset POP AF during the first 30 perioperative days after heart surgery. Other 125 patients with a positive history of paroxysmal or persistent AF were in sinus rhythm at the time of surgery and 87 of them (70%) developed POP AF. Finally, 83 patients had permanent AF when they underwent surgery. All-cause mortality was the primary outcome of the study. We tested the associations of potential determinants with all-cause mortality using univariable and multivariable statistical analyses by means of Cox proportional hazard models. Overall, 473 patients (34%) died during a long-term follow-up. Compared with patients who never developed AF, neither the patients with new-onset POP AF [adjusted HR = 1.31 (95% CI: 0.90–1.89); $P = 0.1609$], nor those with history of AF at the time of surgery (adjusted HR = 1.33, 95% CI: 0.71–2.49; $P = 0.3736$) showed a significantly increased risk of mortality (Figure 1). In new-onset POP AF patients, oral anticoagulation was not associated with mortality [adjusted HR = 1.13 (95% CI: 0.83–1.54), $P = 0.4299$].
Conclusions: In this huge prospective cohort of patients who underwent different types of heart surgery, POP AF was not associated with an increased risk of mortality. In this setting, the role of long-term anticoagulation remains unclear.

204 Permanent his bundle pacing using stylet-driven lead in patients with right atriomegaly: a single-centre experience

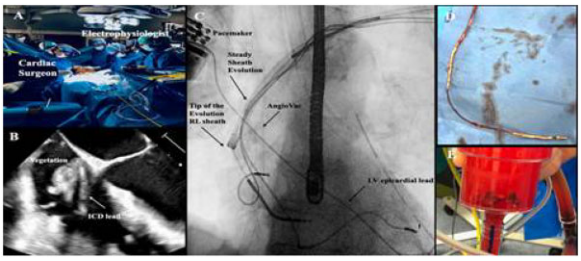
Leonardo Marinaccio[1], Francesco Vetta[2], Eros Rocchetto[3], Paola Napoli[3], and Domenico Marchese[1]
[1]Aulss 6 Euganea, Italy, [2]Saint Camillus International University, Italy, and [3]Biotronik Italia, Italy

Aims: His bundle pacing (HBP) is becoming an increasing widespread approach for physiological pacing. However, successful HBP procedure could be hampered by limited implantation tools especially in challenging anatomies. We aimed to report our experience with HBP technique using a novel stylet-driven lead system in patients with right atriomegaly.
Methods and results: Consecutive patients with right atrium (RA) volume $>25\,ml/m^2$ in men and $>21\,ml/m^2$ in women who underwent permanent HBP for standard indications were enrolled from March 2020 to March 2021. The tool of first choice for HBP attempt was a stylet-driven lead (Solia S 60, Biotronik) delivered via a dedicated introducer sheath (Selectra 3D, Biotronik). The acute, 1-month and 6-month procedural success rates were assessed. We enrolled 24 patients [median age: 75 (70–79) years, 85% men] with an average RA volume of $50.7 \pm 7.8\,ml/m^2$. At implant, conduction system pacing using stylet-driven lead was achieved in 21 patients (87%): 12 (50%) selective HBP, 6 (25%) non-selective HBP, and 3 (12.5%) left bundle branch area pacing. In the three failures, HBP was further attempted with a lumen-less lead with fixed helix (SelectSecure 3830, Medtronic) with final procedural success in two cases. In the successful cases, there was a significant reduction of QRS duration between paced and spontaneous beats [152.5 (130–167.5) ms vs. 130 (122.5–137.5) ms, $P = 0.003$]. No lead dislodgment nor significant pacing threshold increase was observed at 1-month (1.30 ± 0.76 V@0.4 vs. 1.32 ± 0.80 V@0.4 ms, $P > 0.9$) and 6-month follow-up (1.30 ± 0.76 V@0.4 vs. 1.38 ± 0.97 V@0.4 ms, $P = 0.66$).
Conclusions: In patients with right atriomegaly, the novel stylet-driven lead system showed high implant success rates with stable pacing thresholds.

655 The valuable interaction among cardiac surgeon and electrophysiologist for transvenous rotational mechanical lead extraction

Federico Migliore, Vincenzo Tarzia, Pietro Bernardo Dall'Aglio, Pasquale Valerio Falzone, Sabino Iliceto, and Gino Gerosa
Department of Cardiac, Thoracic, Vascular Sciences and Public Health, University of Padova, Italy

Aims: Recent studies have shown that evolution RL bidirectional rotational mechanical sheath (Cook Medical, USA) is an effective and safe technique for transvenous lead extraction (TLE). We reported our experience with the bidirectional rotational mechanical tools using a multidisciplinary approach highlighting the value of a joint cardiac surgeon and electrophysiologist collaboration.
Methods and results: The study population comprised 84 patients (77% male; mean age 65 ± 18 years) undergoing TLE. After multidisciplinary evaluation, a combined procedure was considered. The main indication for TLE was infection in 54 cases (64%).Overall, 152 leads were extracted with a mean implant duration of 94 ± 63 months (range: 6–421). Complete procedural success rate, clinical success rate, and lead removal with clinical success rate were 91.6% (77/84), 97.6% (82/84), and 98.6% (150/152), respectively. Eighteen combined procedures were performed in 12 patients (14%), such as 'hybrid approach' ($n = 2$) or TLE concomitant to: (i) transcatheter aspiration procedure for large vegetation ($n = 8$); (ii) left ventricular assistance device implantation as bridge to cardiac transplantation ($n = 1$); (iii) permanent pacing with epicardial leads ($n = 6$); and (iv) tricuspid valve replacement ($n = 1$).One major complication (1.2%) and 11 (13%) minor complications were encountered. No injury to the superior vena cava occurred and no procedure-related deaths were reported. During a mean time follow-up of 21 ± 18 months, 17 patients (20%) died. They were more often diabetics ($P = 0.02$), and they underwent TLE more often for infection ($P = 0.004$).
Conclusions: Our results support the finding that excellent outcomes can be achieved in performing TLE of chronically implanted leads by using the evolution RL bidirectional rotational mechanical sheath and a multidisciplinary team approach involving both electrophysiologist and cardiac surgeon as first line operators.



655 Figure Combined procedure consisting of transvenous lead extraction of a CRT-D device using the bidirectional rotational mechanical sheath, transcatheter aspiration using an extracorporeal circuit for large vegetations attached to the ICD lead and implantation of a permanent left ventricular epicardial pacing lead for absence of spontaneous rhythm and severe systolic dysfunction. Collaboration between electrophysiologists and cardiac surgeon during the procedure (*A*).Transesophageal echocardiography view during the procedure, showing a large vegetation adhering to the ICD lead course in the right atrium (*B*). Fluoroscopy view during the procedure (*C*). CRT-D, cardiac resynchronization therapy-defibrillator and ICD, implantable cardioverter defibrillator.

460 Assessment of long-term arrhytmic sequelae in patients recovering from COVID-19 infection

Antonio Curnis[1], Gianmarco Arabia[1], Francesca Salghetti[1], Manuel Cerini[1], Antonino Milidoni[1], Emiliano Calvi[1], Daniele Beretta[1], Stefano Bisegna[1], Ashraf Ahmed[2], Gianfranco Mitacchione[2], and Luca Bontempi[4]
[1]Cardiology, Department of Medical and Surgical Specialities, Radiological Sciences and Public Health, University of Brescia, Brescia, Italy, [2]Cardiology Department, Faculty of Medicine, Alexandria University, Alexandria, Egypt, [3]Department of Cardiology, ASST Fatebenefratelli Sacco, Luigi Sacco University Hospital, Milan, Italy, and [4]Department of Cardiology, ASST Bergamo EST, Bolognini Hospital, Seriate, Bergamo, Italy

Aims: COVID-19 has been associated with acute cardiac complications including cardiac arrhythmias. We aimed to assess the prevalence of long-term cardiac arrhythmias in patients recovering from severe COVID-19 infection with proved or suspected of cardiac involvement.
Methods and results: All patients with COVID-19 infection discharged from the cardiology department of our institution from the 1 March to the 30 April 2020 were considered eligible for this study. Patients were fitted out with an adhesive patch and a wireless single-lead 24-h electrocardiogram (ECG) Holter monitor (Rooti Rx® System, Rooti Labs Ltd, Taipei, Taiwan). RootiRx® is a small device consisting of an integrated sensor system, a microelectronic board with memory storage, and an internal rechargeable battery. This system can provide continuous ECG and was set to monitor heart rhythm for 24 h. The Holter system provides also blood pressure measurements and sleep apnea data which are evaluated through chest wall motion/cyclic variation of heart rate and reported along with the sleep efficiency (percentage of time spent asleep while in bed). Arrhythmic findings, sleep apnea detections, and residual COVID-19 symptoms were reported. The study follow-up was performed 174 (range = 166–190) days after hospital discharge in a cohort of 63 (76% males,

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median age 66 years) patients. New diagnosis of atrial fibrillation (AF) was performed in three sinus rhythm patients (4.8%). Eleven (18%) patients had asymptomatic bradycardia (<45 b.p.m.) with no pauses lasting more than 3 s. Non-sustained ventricular tachycardia (<30 s) episodes were recorded in two (3.2%) patients, while no sustained ventricular arrhythmia was documented. The Holter system indicated the presence of moderate-to-severe obstructive sleep apnea episodes in 33 (53%) patients without known history of sleep disorders. Some previously unrecognized long-lasting COVID-19 symptoms were also described: fatigue (10, 16%), myalgia (3, 4.8%), and impaired attention (1, 1.6%).

Conclusions: Six months after the infection, we performed new diagnoses of AF in patients who recovered from severe COVID-19 infection with proved or suspected cardiac involvement using 24-h Holter monitoring. No other arrhythmias were observed, but the Holter system identified obstructive sleep apnea episodes in half of the patients. A relevant percentage of patients also described persisting symptoms of COVID-19 infection. These findings suggest further prospective studies to better describe long-term arrhythmic manifestations and residual symptoms in patients hospitalized with COVID-19 infection.

689 Hybrid transvenous and surgical approach for the extraction of coronary sinus leads: a case series

Ashraf Ahmed[1], Gianmarco Arabia[2], Luca Bontempi[3], Manuel Cerini[2], Francesca Salghetti[2], Gianfranco Mitacchione[4], Antonino Milidoni[2], Lorenzo Stretti[2], Nicola Bernardi[2], Elisa Pezzola[2], Giuliana Cimino[2], Nicola Saccani[2], and Antonio Curnis[2]
[1]Cardiology Department, Faculty of Medicine, Alexandria University, Alexandria, Egypt, [2]Cardiology, Department of Medical and Surgical Specialities, Radiological Sciences and Public Health, University of Brescia, Brescia, Italy, [3]Department of Cardiology, ASST Bergamo EST, Bolognini Hospital, Seriate, Bergamo, Italy, and [4]Department of Cardiology, ASST-Fatebenefratelli Sacco, Luigi Sacco University Hospital, Milan, Italy

Aims: The rates of cardiac device-related infection have increased substantially over the past years. Transvenous lead extraction is the standard therapy for such cases. In some patients, however, the procedure cannot be completed through the transvenous route alone. A hybrid surgical and transvenous approach may provide the solution in such cases.

Methods and results: We present three cases who underwent hybird transvenous and surgical extraction for coronary sinus leads due to infection of CRT-D systems. One patient had an Attain Starfix lead implanted in the coronary sinus. The procedures were performed under local anaesthesia with continuous haemodynamic and transthoracic echocardiographic monitoring. We highlight the characteristics of the patients, the features of the devices, the technical difficulties, and the outcomes of the procedures. In all cases, the right atrial and right ventricular leads were extracted through the transvenous route. In one patient, they were extracted using regular stylets and manual traction, while in the other two patients, telescoping dilator sheaths (Cook), Tightrail hand-powered mechanical sheaths (Spectranetics), and/or Glidelight Excimer Laser sheaths (Spectranetics) were used. The coronary sinus lead could not be retrieved due to extensive fibrosis after utilizing locking stylets and mechanical dilator sheaths in all three cases, in addition to rotational mechanical sheaths and laser sheaths in one case, so the patients were referred to surgery. Two patients underwent left mini-thoracotomy and one patient underwent midline sternotomy to extract the remaining CS lead. The target vein was identified and ligated, then the fibrosis around the lead was dissected, this was followed by lead retrieval through the surgical incision. The patient who underwent sternotomy suffered from mediastinitis, which required reoperation and mediastinal lavage. There were no complications in the other two patients. All three patients were reimplanted with a new CRT-D device on the contralateral side after the resolution of infection.

Conclusions: A hybrid surgical and transvenous approach can be complementary in case the transvenous route alone fails to completely extract the coronary sinus lead. The transvenous approach can be used to free the proximal part of the lead, while the distal adhesions can be removed surgically, preferably though a limited thoracic incision.

714 Effects of direct irradiation on cardiac implantable electronic devices

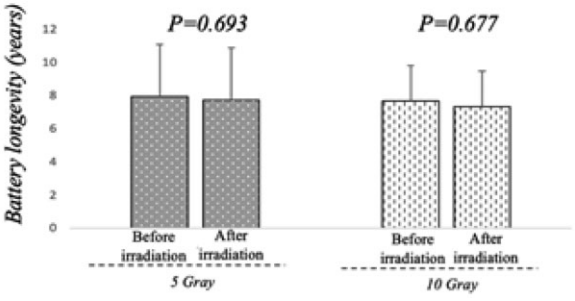
Gianfranco Mitacchione[1], Gianmarco Arabia[2], Luca Bontempi[3], Manuel Cerini[2], Francesca Salghetti[2], Antonino Milidoni[2], Ashraf Ahmed[4], Ludovica Bognoni[2], Mohamed Aboelhassan[5], and Antonio Curnis[2]
[1]Department of Cardiology, ASST-Fatebenefratelli Sacco, Luigi Sacco University Hospital, Milan, Italy, [2]Cardiology, Department of Medical and Surgical Specialities, Radiological Sciences and Public Health, University of Brescia, Brescia, Italy, [3]Department of Cardiology, ASST Bergamo EST, Bolognini Hospital, Seriate, Bergamo, Italy, [4]Cardiology Department, Faculty of Medicine, Alexandria University, Alexandria, Egypt, and [5]Assiut University Heart Hospital, Assiut, Egypt

Aims: Cardiac implantable electronic devices (CIEDs) may sustain damages during a course of radiation therapy, especially when the beam is directed onto the pulse generator, with device electrical reset and/or sudden battery drain. 2010 HRS/ASA expert consensus, and all CIEDs manufacturers, recommend to avoid devices direct irradiation with an accumulated dose that exceed five grays (Gy). In our prospective study, we tested the effects of direct irradiation on CIEDs with different radiation doses, also higher than 5 Gy.

Methods and results: Thirty-seven CIEDs of Medtronic, Abbott, Biotronik, and Boston Scientific were collected during system upgrading or lead extraction procedures. All devices were considered if they had at least 80% of residual battery capacity. All CIEDs were programmed with same default electrical parameters. Depending by CIED type, pacing mode was configured in VVI, VVIR, VDDR, or DDDR, and biventricular stimulation was activated, if present. ICDs electrical therapies were set-up with a pre-determined configuration. All devices were singularly placed in a 30 cm × 30 cm plastic bowl containing 2 l of deionized water that was placed over 5 cm Rockwool to simulate the backscatter and irradiated by a linear accelerator (Elekta Synergy®). CIEDs were divided into two groups depending on irradiation dose delivered: 5 Gy and 10 Gy. No significant differences in battery drainage were observed after irradiation respect to baseline in 5 Gy as well 10 Gy group [7.9 ± 3.1 vs. 7.5 ± 2.1 (years) battery longevity, $P = 0.693$; 7.7 ± 3.1 vs. 7.4 ± 2.1 (years) battery longevity, $P = 0.677$, respectively) (Figure). Moreover, all CIEDS saved the baseline program setting, without device reset events (Table).

Conclusions: Our data confirm that CIEDs direct irradiation of 5 Gy is safe, of note, direct irradiation up to 10 Gy seems to be similarly safe concerning the risk of CIEDs electrical reset and/or unexpected battery drain.

Irradiation	Device	n.37	Output before irradiation	Output after irradiation	Battery reduction (%)
5 Gy	PM	2	4V@1ms	4V@1ms	3.2%
	ICD	6	4V@1ms	4V@1ms	
	CRTD	3	4V@1ms	4V@1ms	
	CRTP	1	4V@1ms	4V@1ms	
10 Gy	PM	13	4V@1ms	4V@1ms	3.9%
	ICD	6	4V@1ms	4V@1ms	
	CRTD	6	4V@1ms	4V@1ms	



536 Intraoperative predictors of long-term pacing threshold improvement in leadless pacemakers

Gianfranco Mitacchione[1], Marco Schiavone[1], Gianmarco Arabia[2], Francesca Salghetti[2], Manuel Cerini[2], Alessio Gasperetti[1], Murizio Viecca[1], Antonio Curnis[2], and Giovanni Forleo[1]
[1]Cardiology Department, Luigi Sacco—University Hospital, Milan, Italy, and [2]Cardiology Department, Spedali Civili Hospital, University of Brescia, Brescia, Italy

Aims: Micra-VR transcatheter pacing system (TPS) has shown strong stability of electrical parameters over time. Nevertheless, a small percentage of patients develops high pacing threshold (PT) (>1 V@0.24 ms) which can decrease the longevity of battery. Our study sought to investigate the intraoperative electrical parameters able to predict device electrical performances during the time.

Methods and results: Patients (pts) implanted with Micra-VR TPS from March 2018 to January 2021 were prospectively considered at the Cardiology Department of Spedali Civili Hospital (Brescia) and Luigi Sacco Hospital (Milan). R-wave sensing amplitude (mV), pacing impedance (Ohm), and PT (V@0.24 ms) were recorded twice: upon Micra final positioning, and after removal of the delivery system. All pts received a follow-up visit at 1- and 12-month after discharge. Electrical parameters were recorded at each visit. A total of 93 pts underwent Micra-VR implantation were enrolled. When compared to the first assessment, R-wave amplitude increased of 19.1% at second control performed after 13 ± 4 min (+1.71 ± 0.2 mV, 95% CI: 1.4–2.02; $P < 0.001$). Conversely, PT significantly decreased of 22.1% at 12-month follow-up respect to baseline (−0.22 ± 0.03 V, 95% CI: −0.13 to −0.31; $P < 0.001$) (Figure 1). Among patients with high PT, acute increase of R-wave sensing of 1.5 mV after 14 ± 4 min significantly predicted PT normalization (≤1 V@0.24 ms) 12 months post-implant ($R = 0.72$, 95% CI: 0.13–0.33, $P < 0.001$) (Figure 2), with a sensitivity of 87.5% (95% CI: 0.61–0.98) and a specificity of 88.8% (95% CI: 0.51–0.99) (Figure 3).

Conclusions: A 1.5 mV increase in R-wave amplitude at implant time is predictive of PT normalization (<1.0 V/0.24 ms) at 12-month FU. This finding may have practical

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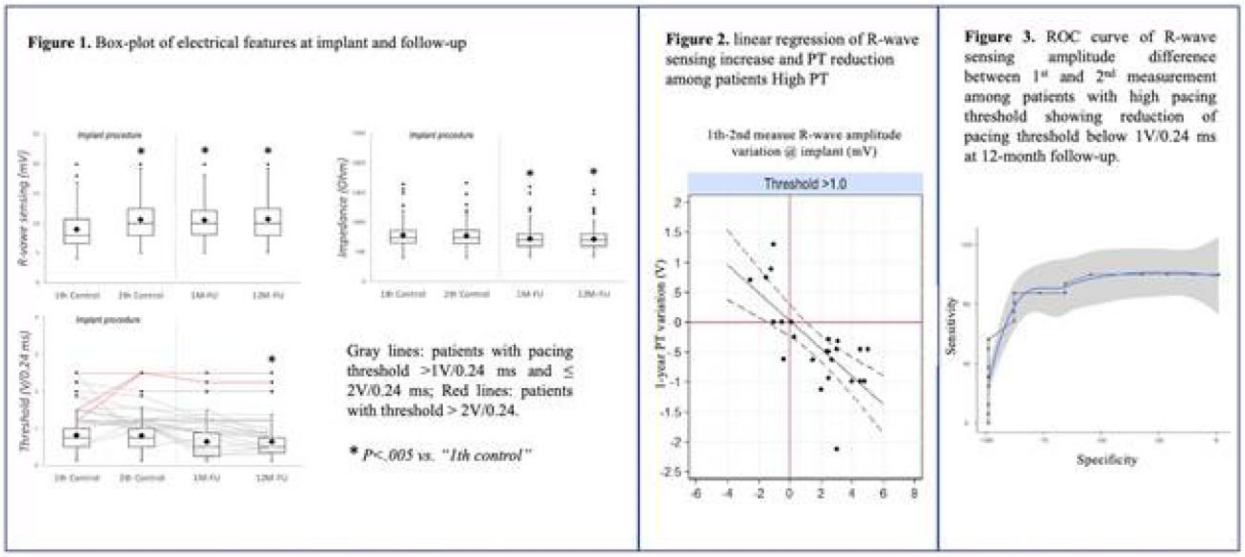
implications for device repositioning in case of HPT at implant. This parameter could be considered for acute device repositioning, particularly in HPT patients.

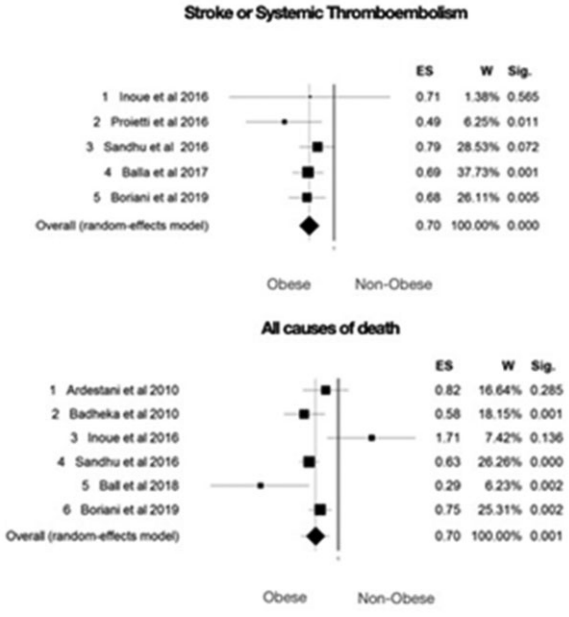


536 Figure

160 The obesity paradox in atrial fibrillation

Marco Favilli[1], Doralisa Morrone[1], Francesco Gentile[1], Giacinta Guarini[1], Riccardo Morganti[2], and Raffaele De Caterina[1]
[1]Dipartimento Cardiotoracico, Azienda Ospedaliera Universitaria Pisana, Italy, and [2]Dipartimento di Statistica, Azienda Ospeadaliera Universitaria Pisana, Italy

Aims: The World Health Organization (WHO) defines obesity as a body mass index (BMI) of $\geq 30\,kg/m^2$. Obesity has been established as an independent risk factor for new-onset atrial fibrillation (AF). Despite the association between obesity and major cardiovascular risk factors and outcomes, some studies showed that obesity may have a protective effect on AF-related outcomes, leading to the controversial concept of the 'obesity paradox'. We carried out a systematic review to explore the 'obesity paradox', providing an overview of the randomized controlled trials (RCTs) and the impact of BMI on AF-related outcomes.



Methods and results: We performed an extensive literature search, from 2000 up to 2021, using the PubMed database, with two independent reviewers (M. F. and F.G.). Discrepancies were resolved by consensus with a senior researcher (D.M.). Studies were eligible if they were RCTs and included outcome comparisons (cardiovascular death, all death, stroke, and major bleeding) with allocation to BMI. We excluded from the analysis trials in which the number of events was not reported. The effect measures of each included study were calculated and reported as hazard ratio (HR) with 95% confidence interval (CI), visually presented in forest plots. A total of 683 studies were available for the analysis; 74 records were included after reading the title; after full reading 8 studies were eligible to be analysed. The meta-analysis of the eight selected randomized controlled clinical trials demonstrated a significantly lower risk of stroke or systemic embolism and all causes of death in obese patient (Figures 1 and 2). A meta-analysis on cardiovascular mortality was not conducted because this was reported only for three trials.
Conclusions: This meta-analysis demonstrated lower stroke and death risk with increasing BMI. Our meta-analysis included only data from RCTs. Observational studies rendered more conflicting results. Because of the few studies included, these apparently protective effects of obesity on the risk of stroke in patients with atrial fibrillation should still be interpreted with caution.

679 Pharmacokinetics of direct oral anticoagulants in patient with atrial fibrillation and extreme obesity

Laura Giannetti, Enrica Pezzullo, Marco Malvezzi Caracciolo D'Aquino, Gabriella Scognamiglio, Erika Parente, Ambra Uccello, Dario Fabiani, Francesco Natale, Paolo Golino, and Vincenzo Russo
Dipartimento di Scienze Mediche Traslazionali. Università degli Studi della Campania Luigi Vanvitelli, Ospedale Monaldi, Napoli, Italy

Aims: Direct oral anticoagulants (DOACs) are recommended in preference to vitamin K antagonists (VKAs) for stroke prevention in patients with atrial fibrillation (AF) eligible for oral anticoagulation therapy; however, data and clinical experiences supporting the use of DOACs in patients with a body mass index $\geq 40\,kg/m^2$ or weight $>120\,kg$ remain limited. The aim of this study was to evaluate the pharmacokinetic properties of DOACs in patients with AF and extreme obesity.
Methods and results: We enrolled all consecutive patients with AF and extreme obesity undergoing treatment with DOACs followed up at Monaldi Hospital, Naples, Italy. To determine peak plasma and trough levels of DOACs, plasma samples were collected at 2nd, 4th, 6th, and 12th hours from the last dose intake in patients receiving apixaban and dabigatran and at the 2nd, 4th, 6th, and 24th hours in those receiving edoxaban and rivaroxaban. The DOACs' peak and trough plasma levels obtained from our study population were compared with those sourced from pharmacokinetic studies among patients without obesity, defined as a normal reference range in the literature. If at least 1 peak or trough plasma level was found below or above the normal reference ranges, the patients were classified as having out-of-

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range DOAC plasma levels. Study population was then divided into in-range and out-of-range groups. Baseline characteristics, including DOAC treatment, were compared between the two groups. Univariate and multivariate logistic regression analyses were performed to identify baseline variables associated with DOACs' plasma concentration out of the expected range. A total of 58 patients [mean (SD) age, 70.93 (8.73) years; 40% female] with extreme obesity [mean (SD) body mass index, 44.43 (3.54) kg/m^2] and AF while undergoing DOAC treatment was included in the present study. In nine patients (15.5%), the DOAC plasma concentrations were out of the expected ranges (out-of-range group);, indicating a greater likelihood of edoxaban 30 mg treatment (33% vs. 2%; $P < 0.01$) and inappropriate DOAC underdosing (56% vs. 4%; $P < 0.005$) compared with the in-range group. According to the multivariate logistic analysis ($P = 0.0011$), the inappropriate DOAC underdosing (hazard ratio = 29.37; $P = 0.0002$) was an independent predictor of DOAC plasma levels out of the expected ranges.

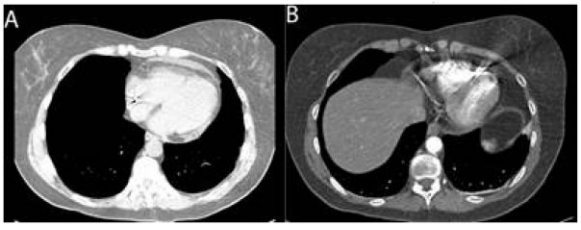
Conclusions: Patients with extreme obesity and AF who were receiving DOAC therapy had DOAC plasma concentrations in the expected range. The inappropriate DOAC underdosing seems to be the only independent clinical factor associated with a plasma concentration of the drug out of the expected range.

656 Cough, a rare and not well recognized symptom of lead perforation

Francesca Parisi[1], Elisabetta Demurtas[1], Marta Allegra[1], Lorenzo Pistelli[1], Francesca Frecentese[1], Giuseppe Dattilo[1], Francesco Luzza[1], Scipione Carerj[1], Pasquale Crea[1], Antonio Micari[2], and Gianluca Di Bella[1]
[1]Department of Clinical and Experimental Medicine, Policlinic 'G. Martino', University of Messina, Italy, and [2]Department of Biomedical and Dental Sciences and Morphological and Functional Imaging, Policlinic 'G. Martino', University of Messina, Italy

Aims: Along with relevant progress in technology, pacemaker implantation is continuously improving its safety and efficacy in treating patients with bradyarrhythmias. Despite this, this procedure has several complications, including haematoma, pneumothorax, lead dislodgement, infection, lead perforation, and tamponade.

Methods and results: A 64-year-old woman underwent loop recorder implantation, after recurrent loss of consciousness, in order to assess arrhythmic causes of syncope. Two weeks later, an episode of paroxysmal complete AV block, conditioning a pause of 3 s, was recorded. Thus, the patient was scheduled for urgent dual-chamber pacemaker implantation. No complication apparently occurred during the procedure. An active fixation ventricular lead was positioned in right ventricular septal apex while passive fixation atrium lead in the right appendage. Soon after implantation the patient started to suffer by non-productive cough, clearly related to ventricular stimulation, either in DDD or in VVI pacing modality. During spontaneous ventricular activation (RBBB) no symptoms occurred. Transthoracic echocardiography, performed the day after implantation, revealed a small pericardial effusion (diastolic diameter < 10 mm) along the apical segments, near the tip of the right ventricular lead. Suspicion of right ventricular lead perforation arised. The patient underwent urgent contrast chest CT confirming pericardial effusion, and showing an intramyocardium placement of the right ventricular apical lead. No active bleeding in pericardium was observed. Due to persistence of symptoms, we decided to perform right ventricular lead repositioning in right middle septum, with pericardiocentesis back-up promptly available. Post-procedure, palpitation, and cough abruptly disappeared. After 3 months follow-up, no significant symptoms were reported and pericardial effusion gradually disappeared.



Conclusions: We describe a singular case of cough, as atypical symptom immediately after pacemaker implantation. Pericardial effusion and contrast-CT showing intramyocardial position of the tip guided our suspicion to a possible right ventricular lead microperforation. Although right ventricular lead parameters were completely normal this findings didn't exclude RV perforation. The lead perforation is known as a rare complication of device implantation. Typical symptoms of RV lead perforation are chest pain and hypotension. The patient described in our case showed a haemodynamically stable pericardial effusion accompanied by non-productive cough, clearly time-related to RV stimulation. In literature, there is only another similar case report. The cough is a rare and not well recognized symptom of lead perforation. Early diagnosis of RV perforation allows to perform urgently and safely (pericardiocentesis back-up) lead replacement/repositioning. Echocardiography and contrast-CT could be useful in order to assess a possible pericardial effusion or intramyocardial/pericardial position of RV lead tip.

525 Incidence and possible determinants of device-pocket haematoma after cardiac implantable electronic devices in patients treated with a pressure dressing

Alessandro Patti[1], Francesco Santoro[1], Pierluigi Pellegrino[1], Girolamo D'Arienzo[1], Domenico Gianfrancesco[2], Francesco Bartolomucci[2], and Natale Daniele Brunetti[1]
[1]Department of Medical and Surgical Sciences, University of Foggia, Italy, and [2]Department of Cardiology, Bonomo Hospital, ASL BAT, Andria, Italy

Aims: Device-pocket haematoma (DPH) occurs in 2–15% of the implantations of cardiac rhythm devices. Major bleedings occur in 0.2–2% of the cases. The present study aims to evaluate the incidence of DPH in patients treated with a pressure dressing after implantation of a pacemaker and to investigate the impact of antiplatelet and anticoagulant therapy on DPH in the same cohort.

Methods and results: A retrospective evaluation on 446 consecutive patients who underwent implantation or replacement of pacemaker/ICD between 2017 and 2018 was performed. Cardiovascular risk factors, clinical parameters, medical history of the patients, as well as their drug history were collected. The presence or absence of perioperative DPH was investigated. All patients were treated with a pressure dressing immediately after the procedure and for the first 24 h. The preliminary results obtained after reviewing the medical records of the 446 patients (age 76.8 ± 10.4 years; 67% males; left ventricular ejection fraction 47.3 ± 12.2%) show an incidence of DPH of 8.1% ($n = 36$). 332 (74%) of the patients had documented hypertension, 131 (29%) diabetes, 213 (48%) were taking antiplatelet medications, and 150 (34%) were taking anticoagulants. No significant differences were found directly comparing the main variables under study between patients who experienced DPH and those who did not. However, at binomial logistic regression analysis, performed including antithrombotic therapies, sex, and age, a tendency of patients treated with warfarin to experience DPH emerged (OR : 3.25, 95% CI : 1.00–10.50; $P = 0.049$).

Conclusions: The preliminary results of the present study show an incidence of DPH of 8.1% in patients treated with a pressure dressing after pacemaker implantation. Between antithrombotic therapies, sex and age, anticoagulation therapy with warfarin appeared to be correlated with an increased risk of DPH.

707 Transvenous radiofrequency ablation of epicardial posterior-septal accessory pathways in children with WPW syndrome: can technology and imaging innovations improve the outcome?

Vincenzo Pazzano, Pietro Paolo Tamborrino, Corrado Di Mambro, Massimo Stefano Silvetti, and Fabrizio Drago
Ospedale Pediatrico Bambino Gesù, Roma, Italy

Aims: The aim of the study was to analyse our recent single-centre experience about epicardial posterior-septal accessory pathways transcatheter ablation in children and young patients using radiofrequency through the coronary sinus, in order to understand which mapping and ablation strategy is associated with higher success rate and safety.

Methods and results: We reviewed all the cases of ablation of overt accessory pathways (in Wolff-Parkinson-White syndrome) with epicardial posterior-septal localization performed in children or young patients at our institution in the last 5 years. Twenty-two paediatric patients (mean age: 13 ± 3 years) with epicardial posterior-septal accessory pathways (15 in coronary sinus and 7 in the Middle Cardiac Vein) underwent radiofrequency transcatheter ablation with CARTO 3TM. Acute success rate was 77%. No patient was lost to follow-up (mean time 14.4 ± 9 months). The recurrence rate was 18%. Two patients underwent a successful redo-procedure; the overall long-term success rate was 68%. NAVISTAR® catheter presented the highest acute success rate in the coronary sinus. NAVISTAR SMARTTOUCH® was the only catheter that did not present recurrences after the acute success and it was successfully used in two patients previously unsuccessfully treated with a NAVISTAR THERMOCOOL®. Integration with angio-CT of coronary sinus branches obtained with CARTOMERGE was associated with higher success rate in patients with a previous failed ablation attempt.

Conclusions: Epicardial posterior-septal accessory pathways can be successfully treated with transvenous radiofrequency ablation in more than half of the cases in children/young patients. Acute success rate does not seem to depend on catheters used but contact-force catheter seems to be useful in cases with recurrences. Image integration with cardiac-CT reconstruction of coronary sinus branches anatomy can be useful to better guide ablation in case of previously failed attempts.

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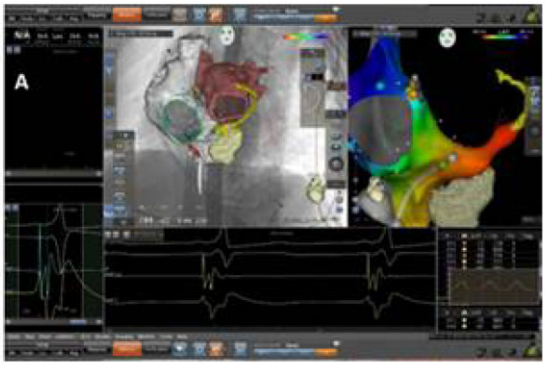

116 Continuous vs. discontinuous arrhythmia monitoring in patients with myocarditis: insights from a single-centre experience

Giovanni Peretto, Alessandra Marzi, Gabriele Paglino, Patrizio Mazzone, Simone Sala, Paolo Della Bella
IRCCS San Raffaele Scientific Institute, Milan, Italy

Aims: Although potentially life-threatening, arrhythmias in myocarditis are underreported. To assess diagnostic yield and clinical impact of continuous arrhythmia monitoring (CAM) in patients with arrhythmic myocarditis.
Methods and results: We enrolled consecutive adult patients ($n = 104$; 71% males, age 47 ± 11 years, mean LVEF 50 ± 13%) with biopsy-proven active myocarditis and *de novo* ventricular arrhythmias (VA). All patients underwent prospective monitoring by both sequential 24-h Holter ECGs (4/y in the first year; 2/y in years 2–5; 1/y later) and CAM, including either ICD ($n = 62$; 60%) or loop recorder ($n = 42$; 40%). By 3.7 ± 1.6 year follow-up, 45 patients (43%) had VT, 67 (64%) NSVT, and 102 (98%) premature ventricular complexes (PVCs). As compared to Holter ECG (average 9.5 exams per patient), CAM identified more patients with VA (VT: 45 vs. 4; NSVT: 64 vs. 45; both $P < 0.001$), more VA episodes (VT: 100 vs. 4%; NSVT: 91 vs. 12%), and earlier NSVT timing (median 6 vs. 24 months, $P < 0.001$). Conversely, Holter ECG allowed VA morphology characterization and daily PVC quantification. The time to first treatment modification was 12 ± 9 months by CAM vs. 33 ± 16 months by Holter ECG ($P < 0.001$), and drug withdrawal was always CAM-dependent. Guided by CAM findings, 8 patients (8%) started anticoagulants for newly diagnosed atrial arrhythmias. Differently from ICDs, loop recorders did not interfere with the interpretation of cardiac magnetic resonance.
Conclusions: In patients with arrhythmic myocarditis, CAM allowed accurate arrhythmia detection and showed a considerable clinical impact. As a complementary exam, VA characterization and PVC burden were better assessed by repeated Holter ECGs.

493 Prognostic value of myocardial scar and chamber enlargement at electroanatomical mapping during catheter ablation in adult congenital heart disease

Francesco Perna[1], Maria Lucia Narducci[1,2], Rocco Sabarese[1], Eleonora Ruscio[1], Roberto Scacciavillani[1], Francesco Raffaele Spera[1], Bencardino Gianluigi[1], Gaetano Pinnacchio[1], Gemma Pelargonio[1,2], and Filippo Crea[1,2]
[1]Dipartimento di Scienze Cardiovascolari, Fondazione Policlinico Universitario Agostino Gemelli IRCCS, Italy, and [2]Università Cattolica del Sacro Cuore, Roma, Italy

Aims: Atrial and ventricular tachyarrhythmias are common among patients with adult congenital heart disease (ACHD) and can impair quality of life and prognosis. Catheter ablation is often the main treatment option in this population, despite anatomical hurdles. Substrate mapping findings have not been thoroughly investigated as predictors of arrhythmia recurrence success and cardiovascular clinical outcome after ablation. We sought to determine the prognostic value of myocardial scar and chamber enlargement detected at electroanatomical mapping in ACHD patients undergoing catheter ablation of tachyarrhythmias.
Methods and results: Consecutive ACHD patients undergoing catheter ablation of atrial and ventricular tachycardias using different electroanatomical mapping systems were retrospectively identified from a hospital-based database. Scar extent detected at the electroanatomical mapping, as well as the total mapped area, was calculated. Arrhythmia recurrence, hospitalization for cardiovascular (CV) reasons, and a combined endpoint (arrhythmia recurrence and/or CV hospitalization) were evaluated during the follow-up. The relationship between the aforementioned electroanatomical findings and the patients' outcome was assessed. Twenty patients (12 male, 60%; mean age 40 ± 11 years) undergoing atrial ($n = 14$; 70%) or ventricular ($n = 6$; 30%) tachyarrhythmia were included. Acute procedural success (arrhythmia termination and/or no reinduction) was achieved in all the patients. At a mean follow-up of 171 ± 135 weeks, eight patients (40%) had arrhythmia recurrence (4/6 in the ventricular tachycardia group, 67%, 4/14 in the atrial tachycardia group, 28%). Patients with arrhythmia recurrence had a more extensive bipolar scar ($P = 0.029$) and a larger total mapped area ($P = 0.03$) than patients without recurrence, and so did the patients with the composite endpoint ($P = 0.029$ and $P = 0.03$, respectively). Patients with subsequent CV hospitalization had a larger total mapped area than patients without CV hospitalization ($P = 0.017$). The presence of a bipolar scar $\geq 22.95\ cm^2$ predicted arrhythmia relapse (0.039) at the multivariate analysis.
Conclusions: Patients with ACHD show a high recurrence rate after catheter ablation, especially for ventricular tachycardias. A large bipolar scar at the electroanatomical mapping and total mapped area predict arrhythmia recurrence, likely due to the presence of more extensive reentry circuits. A large total mapped area, which may reflect a greater disease severity, predicts both arrhythmia recurrence and CV hospitalizations. Early referral of ACHD patients for catheter ablation may be a sound strategy in order to perform the procedure in the setting of less advanced heart disease.

629 CPVT and complete atrio-ventricular block: two faces of the same coin?

Mattia Petrungaro[1], Martina Nesti[2], Elena Cavaretta[3], Zefferino Palamà[4], Antonio Scarà[5], Annamaria Martino[5], Antonio Gianluca Robles[6], Melissa De Maio[7], Silvio Romano[6], Maria Penco[6], Leonardo Calò[5], and Luigi Sciarra[5]
[1]Cardiology Department, Faculty of Medicine and Psychology, Sant'Andrea Hospital, University of Rome Sapienza, Rome, Italy, [2]Cardiovascular and Neurological Department, San Donato Hospital, Arezzo, Italy, [3]Department of Medical-Surgical Sciences and Biotechnologies, Sapienza University, Rome, Italy, [4]Cardiology Unit, SS. Annunziata Hospital, Taranto, Italy, [5]Cardiology Department, Policlinico Casilino, Rome, Italy, [6]Department of Life, Health and Environmental Sciences, University of L'Aquila, L'Aquila, Italy, [7]Sapienza University, Rome, Italy, and [8]Chair of Cardiology, University of L'Aquila, 61700 L'Aquila, Italy

Aims: Catecholaminergic polymorphic ventricular tachycardia (CPVT) is an electrical genetic disease characterized by induction of malignant ventricular arrhythmias during adrenergic stress in structurally normal hearts. CPVT is correlated to syncope or sudden cardiac death (SCD). Usually, it is caused by an autosomal dominant mutation in the cardiac ryanodine receptor (RyR2), an essential gene for Ca2+ homeostasis.
Methods and results: Our case series refers to: a man (59 years) who came to our attention for a clinical check-up 4 years after implanting bicameral pacemaker at the age of 55 years for complete AV block; and his three sons (E. female 27 years; D. male 25 years; and B. female 17 years) who had evidence of polymorphic non-sustained ventricular tachycardia (NSVT) with increasing effort during stress test. The three sons performed cardiac MRI and underwent genetic test. All three were found to be carriers of the same microdeletion of the RYR 2 gene (1q43- extended for about 49 kb) at the genetic test. They also have non-compacted myocardium at cardiac MRI. The father was also found to be a carrier of the same genetic microdeletion, while the mother was negative to the genetic test. The man was diagnosed to be a carrier of the mutation 4 years after pacemaker implantation.
Conclusions: Mutation of the RyR2 may have different phenotypic expressions and can be correlated to various clinical manifestations. CPVT is the most common one, and its prompt identification is crucial to prevent subjects from sport-related risks and to plan an efficient therapy. Our case series provides evidence for a careful consideration of such a genetic disorder even in presence of a major AV conduction disease in a relatively young subject. In the present case series, no major adverse events occurred. However, we can, in the aftermath, speculate that if a genetic disorder had been suspected when AV block occurred, a timely diagnosis could have been made earlier also for the sons.

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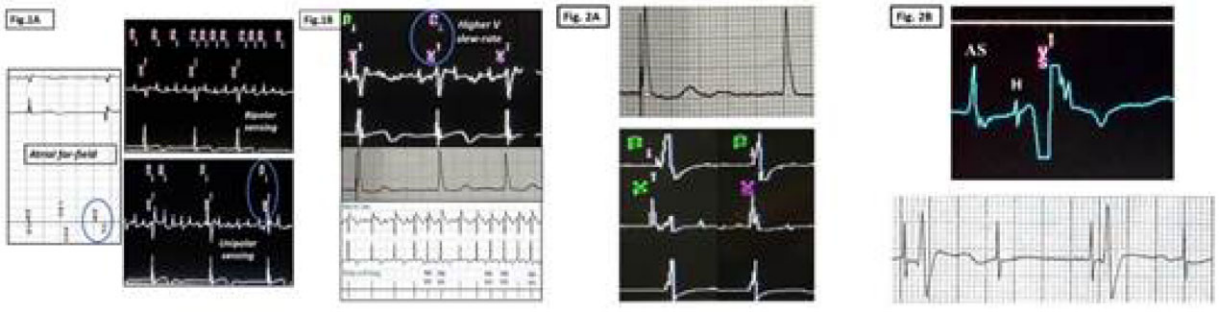
Referto esame array CGH: Il test mediante tecnica di SNP-array con piattaforma CytoSNP-850K ad una risoluzione media di 100 Kb, ha evidenziato una microdelezione, a segregazione paterna, del braccio lungo di un cromosoma 1, nella regione 1q43, estesa circa 49 Kb, contente parte del gene OMIM (Online Mendelian Inheritance in Man) Disease Causing RYR2. La microdelezione riscontrata è descritta in letteratura scientifica come associata all'indicazione clinica all'indagine (Ivone U. S. Leong et al., Ups J Med Sci. 2015).

557 His bundle pacing: how to troubleshoot the implantation of a ventricular back-up lead

Giuseppe Pio Piemontese, Lorenzo Bartoli, Giovanni Statuto, Andrea Angeletti, Giulia Massaro, Cristian Martignani, Matteo Ziacchi, and Mauro Biffi
Azienda Ospedaliero-Universitaria IRCCS Sant'Orsola-Malpighi, Bologna, Italy

Aims: Interest in permanent His bundle pacing (HBP) as a means of both preventing pacing-induced cardiomyopathy and providing physiological resynchronization by normalization of His-Purkinje activation is constantly growing. Current devices are not specifically designed for HBP, which gives rise to programming challenges. To evaluate the critical troubleshooting HBP options in patients with permanent atrial fibrillation (AF) and variable degree of atrio-ventricular block (AVB) who receive HBP through a lead connected to the atrial port, and an additional ventricular 'backup'.
Methods and results: Between December 2018 and July 2021, 156 consecutive patients with indication for pacing underwent HBP. Among these, 37 had permanent AF with documented symptomatic pauses. Fourteen of them received a dual-chamber device which was used to place a backup right ventricle (RV) lead; in this scenario, the His lead is implanted in the right atrial (RA) port, the RV lead in the RV port. Depending on the presence of an additional left ventricle (LV) lead, either a dual-chamber and a CRT device can be used. In this context, the events marked as atrial sensed (As) or paced (Ap) are indeed ventricular, so that sensing is more complex. A clinical scenario is atrial activity oversensed on the His channel (As) leading to RV dyssynchronous pacing in the ventricular safety pacing (VSP) window. A second one is intrinsic QRS undersensing causing inappropriate His pacing. The interplay of intrinsic ventricular activity (rate, signal amplitude, and slew rate on both the His and the ventricular channel) and of the HV interval may be of key importance to troubleshoot As-Vp (atrial sensed-ventricular paced) (Figure 1A) as well as Vs-Ab (ventricular sensed-atrial blanking period) sequences (Figure 1B). Changing sensitivity and sensing configuration may help to fix these issues. DVI(R) mode programming may indeed prove safer than DDD(R) in the setting of preserved intrinsic activity or in the event of intermittent His capture loss. Paced AV delay should be programmed slightly longer than H-V+QRS duration to avoid unnecessary RV pacing with pseudo-fusion (too short) (Figure 2A) and possibly R/T events (too long). Stability of H-V interval and of QRS duration must be verified at each device follow-up by decremental His pacing to ensure consistent sensitivity of the ventricular signal beyond stable His capture, that may be challenged by infra-Hisian block (Figure 2B).
Conclusions: Owing to the absence of HBP-specific devices, HBP shall be made safe and effective by careful troubleshooting, consisting of sensitivity setting, paced AV interval and mode programming.



557 Figure

787 Ablation of the ventricular ectopic foci: a therapeutic option for dilated cardiomyopathy due to arrhythmic MVP

Lorenzo Pistelli[1], Carla Giustetto[2], Matteo Anselmino[2], Francesca De Lio[2], Federico Ferraris[2], Irene Landi[2], Simone Frea[2], Riccardo Faletti[3], Marco Gatti[3], Fiorenzo Gaita[2], and Gaetano Maria De Ferrari[2]
[1]Dipartimento di Mdicina Clinica e Sperimentale, Policlinico 'G. Martino', Università di Messina, Messina, Italy, [2]Divisione di Cardiologia, Dipartimento di Scienze Mediche, Università di Torino, Torino, Italy, and [3]Unità di Radiologia, Dipartimento di Scienze Chirurgiche, Università di Torino, Torino, Italy

Aims: A subset of patients with mitral valve prolapse (MVP) are affected by a still not well understood condition characterized by frequent ventricular arrhythmias (mostly originating from papillary muscles) and sudden cardiac death (SCD). It is called MVP malignant syndrome (MVP MS). In these patients, the high arrhythmic burden may lead to left ventricular (LV) dyssynchrony and dysfunction, determining a tachycardia-induced cardiomyopathy (TIC). Reduction in arrhythmic burden determines LV recovery and ejection fraction improvement and interrupts LV progressive dilatation.
Methods and reports: We report the case of a 52-year-old woman with MVP and family history of both MVP and SCD who was referred to our department for symptomatic extrasystoles and dyspnoea during exercise. Palpitations begun 11 years before: in that occasion she performed a 3-lead-ECG-Holter monitoring which documented 3457 ventricular extrasystoles. Transthoracic echocardiography (TTE) showed normal LV dimension and function and a myxomatous mitral valve with prolapse of both leaflets. At that time beta-blocker therapy was introduced, but soon suspended because of patient's clinical intolerance (bradycardia and hypotension). Since then she was lost at follow-up for years, until symptoms worsened. When she came to our attention, TTE showed dilated and hypokinetic LV (ejection fraction was 38%, S2 wave at TDI was 6.4 cm/s and global longitudinal strain value was −13%). CMR was performed and confirmed TTE findings. Mitral-annulus disjunction was described in anterior, lateral, and posterior wall and late gadolinium enhancement analyses showed subendocardial fibrosis in correspondence of the posterior papillary muscle (PM) and in the mid-inferior wall. Holter monitoring enlightened a high arrhythmic burden with 24 065 premature ventricular complexes (PVCs) of two morphologies (right bundle branch block-like and −120° axis and right bundle branch block-like and −75° axis). During stress test, PVCs increased as the heart rate increased, resulting in bigeminism at peak exercise. Considering all these features, we hypothesized a case of MVP MS in which the high ventricular arrhythmic burden resulted in TIC. Any available pharmacological attempt to reduce arrhythmias failed. Transcatheter (TC) ablation of PVCs was then proposed. Electrophysiological study identified the inner part of the posterior papillary muscle implantation region and the antero-lateral basal wall as PVCs sites of origin. Radiofrequency ablation was performed in both sites. After the procedure, despite an incomplete suppression of the posterior PM focus, 12-lead 24-h Holter monitoring and TTE performed during the hospitalization showed a consistent arrhythmic burden reduction and LV function improvement. At 6 months from the procedure, symptoms improved and Holter monitoring showed 7515 PVCs with a 54% arrhythmic burden reduction compared with the presentation. TE showed lower LV end-diastolic volume and an increase in ejection fraction up to 47%; global longitudinal strain was −17% and TDI showed a S2 wave on lateral wall of

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11 cm/s, confirming left ventricle improvement after the arrhythmic burden reduction.
Conclusions: Complete suppression of PMs PVCs with TC ablation is difficult to obtain, especially when the focus is in the inner part of the PM and TC ablation of ventricular arrhythmias in MVP patients has not yet demonstrated his efficacy in reducing SCD. Nevertheless, it should be taken into consideration to obtain at least PVCs reduction in patients with high arrhythmic burden leading to TIC.

258 Cancer incidence during follow-up in patients with new onset atrial fibrillation treated with DOACs and its impact on bleeding risk

Francesco Angeli, Lorenzo Bartoli, Michele Fabrizio, Matteo Armillotta, Angelo Sansonetti, Andrea Stefanizzi, Sara Amicone, Chiara Chiti, Ilenia Magnani, Luca Bergamaschi, Alberto Foà, Pasquale Paolisso, Nazzareno Galiè, and Carmine Pizzi
Cardiology, Department of Experimental, Diagnostic and Specialty Medicine, University Hospital Policlinico S. Orsola-Malpighi, Italy

Aims: Cancer is increasingly recognized as strictly related to atrial fibrillation (AF). In patients with AF, the relationship between cancer and cardioembolic or bleeding risk during oral anticoagulant therapy is unknown. To assess the bleeding and ischaemic burden of a baseline or newly diagnosed cancer in patients treated with direct oral anticoagulants (DOACs) for non-valvular AF (NVAF).
Methods and results: All consecutive patients treated with DOACs were enrolled among those with new-onset AF and indication for oral anticoagulant between January 2017 and March 2019. During follow-up, bleeding events, newly diagnosed primitive or metastatic malignancy and major cardiovascular events (MACEs) were evaluated. At baseline, CHA2DS2-VASc, HAS-BLED, ATRIA, and ORBIT scores were used to assess the haemorrhagic and ischaemic risk. Major bleedings (MBs) were defined according to the ISTH definition. Anaemia was defined as haemoglobin levels below 11 g/dl in women and 12 mg/dl in men. 1258 patients constituted the study population and followed for a mean time of 21.6 ± 9.5 months. Overall, 66 patients (5.2%) were affected by malignant neoplasia at baseline, whereas 59 (4.7%) were diagnosed with a malignancy during follow-up. Among baseline characteristics, anaemia was associated with cancer at enrolment (43.9% vs. 22.5%, $P < 0.001$) but not at follow-up (29.3% vs. 23.4%, $P = 0.341$). MACEs were not associated with cancer at baseline (5.3% vs. 5.2%, $P = 1.0$) and at follow-up (5% vs. 4.9%, $P = 1.0$). No association was observed between major ischaemic events and cancer at enrolment or follow-up (5.3% vs. 4.4%, $P = 0.83$ and 4.4% vs. 5%, $P = 0.82$). Despite no statistically significant differences in haemorrhagic risk at baseline, the overall bleeding events and MB were associated with newly diagnosed cancer (9.2% vs. 3.9%, $P = 0.001$ and 13.8% vs. 4.5%, $P = 0.001$, respectively) but not at baseline (5.2% vs. 5.5%, $P = 0.82$ and 9.2% vs. 5.2%, $P = 0.162$). At multivariate analysis adjusted for age, hypertension and renal function, anaemia, and a newly diagnosed cancer during follow-up remained independent predictor of MB [respectively, HR: 1.27, 95% CI: 1.52–1.06, $P = 0.009$ and HR: 3.53, 95% CI: 7.71–1.62, $P = 0.001$].
Conclusions: Bleeding risk assessment is an ongoing challenge in patients with NVAF on DOACs. During follow-up, newly diagnosed primitive or metastatic cancer is a strong predictor of bleeding regardless of baseline haemorrhagic risk assessment. In contrast, such association is not observed with malignancy at baseline. A proper diagnosis and treatment could therefore decrease cancer-related bleeding risk. On the contrary, our study shows that cancer is not an ischaemic risk modifier, either diagnosed at baseline or follow-up.

284 Worsening renal function as an outcome predictor in patients with new onset atrial fibrillation on direct oral anticoagulant

Lorenzo Bartoli[1,2], Francesco Angeli[1,2], Matteo Armillotta[1,2], Angelo Sansonetti[1,2], Michele Fabrizio[1,2], Ilenia Magnani[1,2], Andrea Stefanizzi[1,2], Alberto Foà[1,2], Pasquale Paolisso[1,2], Andrea Rinaldi[1,2], Nazzareno Galiè[1,2], and Carmine Pizzi[1,2]
[1]IRCCS Policlinico San'Orsola-Malpighi, Italy, and [2]DIMES-Dipartimento di Medicina Specialistica, Diagnostica e Sperimentale, Italy

Aims: In patients with atrial fibrillation (AF), baseline kidney function is used to guide oral anticoagulant (OA) selection and dosing, and chronic kidney disease (CKD) is a significant outcome predictor. However, the incidence of worsening renal function (WRF) and its prognostic role during treatment with direct oral anticoagulants (DOACS) has been poorly explored. To assess the prognostic role of WRF in terms of bleedings and major adverse cardiovascular events (MACEs) in a cohort of patients with newly diagnosed non-valvular AF (NVAF) treated with DOACs.
Methods and results: Between January 2017 and March 2019, we enrolled all the patients with newly diagnosed NVAF and OA indication, treated with DOACs. Renal function was assessed using the mean value of the estimated glomerular filtration rates (eGFR) calculated using Cockcroft–Gault (CG), modification of diet in renal disease (MDRD), and Chronic Kidney Disease Epidemiology Collaboration (CKD-EPI) formulas. CHA2DS2-VASc and HAS-BLED scores were used at baseline to estimate the ischaemic and haemorrhagic risk, respectively. At follow-up, WRF was identified as a decrease in eGFR of at least 20% while bleedings were classified according to the international society of thrombosis and haemostasis (ISTH) criteria. Finally, we defined AF progression as the transition from paroxysmal to persistent or permanent AF or from persistent to permanent AF. 1009 patients with newly diagnosed NVAF started on DOAC were enrolled. They were followed-up for 21.6 ± 9.5 months. Overall, WRF was observed in 181 cases (18%). Patients with WRF had higher rates of progression of AF (18.5% vs. 11.8%, $P = 0.02$), MACEs (20.4% vs. 12.9%, $P = 0.09$) and major bleedings (MBs) (9.4% vs. 4.7%, $P = 0.013$). WRF did not correlate with all bleedings, stroke, or acute coronary syndrome (ACS). However, those who presented WRF using CKD-EPI formula had higher ACS incidence (6.1% vs. 2.5%, $P = 0.015$), and generally better-predicted MACEs. At multivariate analysis adjusted for age, hypertension, baseline HAS-BLED score and WRF, the latter emerged as an independent predictor of MB (OR: 1.9, 95% CI: 1.059–3.51).
Conclusions: In patients with newly diagnosed NVAF treated with DOACs, WRF is associated with AF progression and MACEs, and emerged as an independent predictor of major bleedings. WRF evaluated with CKD-EPI formula better predicted MACEs.

614 Implantable cardiac monitors predict arrhythmic events in post-infarction patients with mildly reduced left ventricular ejection fraction

Vincenzo Riverso[1], Antonio Curcio[1], Alessia Tempestini[1], Emilia De Luca[1], Sabrina La Bella[1], Simona De Luca[1], Alessandra Critelli[1], Eugenia Pasceri[1], Giuseppe Santarpia[1], and Ciro Indolfi[1,2]
[1]Division of Cardiology, Department of Medical and Surgical Sciences, Magna Graecia University, Catanzaro, Italy, and [2]Mediterranea Cardiocentro, Naples, Italy

Aims: Complications of acute myocardial infarction (MI) can be life-threatening leading to sudden cardiac death. While guidelines recommend prompt revascularization and prolonged intensive care hospitalization, predictors of major adverse cardiovascular outcomes are yet poorly understood. The role of implantable cardioverter-defibrillators, even in cases of non-sustained arrhythmias is still debated. To date, it is unknown how to follow-up patients with mild cardiac dysfunction after MI. Implantable cardiac monitors (ICMs) can be helpful for stratifying patients in the early discharge period, and remote monitoring might speed up arrhythmia recognition and treatment. We investigated the role of remote monitoring of ICMs to detect arrhythmic events in post-MI patients without overt cardiac dysfunction.
Methods and results: We enrolled 13 patients (9 males; 69.8 years) after either ST-segment ($N = 7$) or non-ST-segment elevation ($N = 6$) MI with a left ventricular ejection fraction (LVEF) >35%, admitted to our coronary care unit for urgent revascularization between September 2019 and September 2021. Twelve patients underwent percutaneous myocardial revascularization, whereas one was treated with medical therapy only. All patients received an ICM during hospitalization according to echo and EKG parameters. We considered LVEF $\leq$ 40% as sole risk factor or LVEF between 40% and 50% in addition to either PQ length prolongation, or QRS widening, or pathologic heart rate variability, or non-sustained ventricular tachycardia/paroxysmal advanced second degree atrioventricular block. Patients with multiple revascularization procedures and several hospital admissions were excluded. Implanted ICM were frequently monitored both remotely and in-office when required. During follow-up, brady- and tachy-arrhythmias were recorded in four patients (30.8%). The remote monitoring of the ICM documented new-onset atrial fibrillation, high-degree atrioventricular block, severe bradycardia, and sustained ventricular tachycardia. Three patients required hospitalization and upgrade of the implanted device with pacemakers and cardioverter/defibrillator. For arrhythmic risk stratification, patients were divided into two subgroups; group A included patients with LVEF 40% associated with heart rate > 60 b.p.m., PQ length >160 ms and QRS width >86 ms ($N = 4$); group B included patients with EF 41%/50%, PQ length <159 and QRS width <85 ms ($N = 10$). First group experienced more advanced rhythm disorders than group B ($P < 0.05$). Device implantation was significantly higher in group A ($P < 0.05$%).
Conclusions: OFF-label implementation of ICMs coupled with remote device monitoring may be effective for early detection of serious adverse cardiac rhythm alterations in patients after MI and LVEF higher than 35%. Further monitoring is ongoing for assessing the occurrence of multiple arrhythmias or their increased occurrence.

543 Paroxysmal atrial fibrillation in a young athlete: the importance of knowing the electrophysiological mechanism

Antonio Gianluca Robles[1], Mattia Petrungaro[2], Maria Penco[1], Silvio Romano[1], and Luigi Sciarra[1,3]
[1]Department of Life, Health and Environmental Sciences, University of L'Aquila, L'Aquila, Italy, [2]Cardiology Department, Faculty of Medicine and Psychology, Sant'Andrea Hospital, University of Rome Sapienza, Rome, Italy, and [3]Cardiology Unit, Policlinico Casilino, Rome, Italy

Aims: Atrial fibrillation (AF) is the most commonly sustained cardiac arrhythmia encountered in clinical practice. The prevalence of arrhythmia increases with age. However, paroxysmal AF can also arise in young or middle-aged individuals or

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otherwise healthy athletes. Electrical isolation of the pulmonary veins is the approach recommended by the guidelines for the ablative treatment of patients with symptomatic AF, although the risks associated with the procedure are not yet negligible. However, in order to increase the risk/benefit ratio of any ablation, it may be important to better define the electrophysiological mechanism underlying the arrhythmia. This could help plan a safer and more effective therapeutic approach, especially in young patients and/or patients with a structurally healthy heart and a prolonged history of paroxysmal AF.
Methods and results: We report the case of a 19-year-old basketball player who is strongly symptomatic for palpitations due to AF episodes. The electrophysiological study revealed the true mechanism underlying AF episodes: degeneration into AF of an atrial tachycardia (AT) originating from the right atrium lateral wall. Once the ectopic focus of AT had been ablated, the patient remained totally asymptomatic at the 4-year follow-up.
Conclusions: This case underlines the importance of the concept that young subjects with 'lone AF', in the absence of structural heart disease, may have different mechanisms underlying the arrhythmic phenomenon. In our case, the electrophysiological study enabled us to reconstruct the electrogenic mechanism at the base of the arrhythmia, allowing us to carry out a safe and effective therapy.

547 Supernormal conduction of an accessory pathway: the case of a young sportsman

Antonio Gianluca Robles[1], Mattia Petrungaro[2], Maria Penco[1], Silvio Romano[1], and Luigi Sciarra[1,3]
[1]Department of Life, Health and Environmental Sciences, University of L'Aquila, L'Aquila, Italy, [2]Cardiology Department, Faculty of Medicine and Psychology, Sant'Andrea Hospital, University of Rome Sapienza, Rome, Italy, and [3]Cardiology Unit, Policlinico Casilino, Rome, Italy

Aims: Ventricular pre-excitation is defined by the presence of all of the following electrocardiographic criteria: PQ interval duration $\leq$120 ms, QRS duration $\geq$120 ms, and presence of δ wave (defined as initial 'slurring' of the QRS complex). Ventricular pre-excitation together with the presence of symptoms (orthodromic and/or antidromic atrioventricular reentry tachycardia, atrial fibrillation) defines Wolff-Parkinson-White (WPW) syndrome. The anatomical substrate of ventricular pre-excitation consists of an extranodal accessory atrio-ventricular connection: the so-called Kent bundle. Such pathways can have antegrade, retrograde, or mixed conductive properties. Accessory pathways endowed with anterograde conductive capability may be responsible for manifest, intermittent, or non-manifest ventricular pre-excitation depending on whether it is respectively always visible on the ECG, not always visible on the ECG and not visible on the ECG even though the pathway has the ability to antegrade conduction. The rare phenomenon of supernormal conduction of anomalous pathways is part of the manifest pre-excitation, which represents the topic of the case reported below.
Methods and results: We report the clinical case of a young not agonist sportsman undergoing an electrophysiological study (SEF) because of he is suffering from ventricular pre-excitation. The SEF did not showed the inducibility of arrhythmias and, at the same time, apparently it showed low risk characteristics of the pathway even during adrenergic stimulus. However, a careful study, performed with atrial stimulation with couplings up to refractoriness of the atrioventricular node revealed supernormal conduction properties of the Kent bundle which proved to have high risk characteristics according to current guidelines and, therefore, was effectively treated with catheter ablation.
Conclusions: This case invites us to careful studying of accessory pathways properties, especially since, although rare, they may possess supernormal conduction characteristics capable of determining high ventricular rates in the case of sustained atrial tachyarrhythmias, especially in conditions of adrenergic hyperactivity.

108 Atrial fibrillation effects on coronary perfusion across the different myocardial layers: a computational analysis

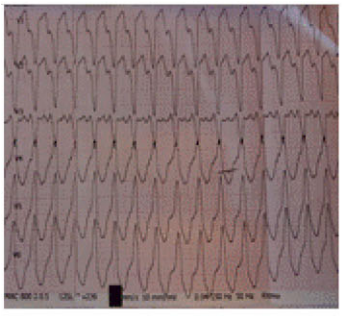
Andrea Saglietto[1], Stefania Scarsoglio[2], Matteo Fois[2], Luca Ridolfi[3], Gaetano Maria De Ferrari[1], and Matteo Anselmino[1]
[1]Division of Cardiology, Department of Medical Sciences, University of Turin, Turin, Italy, [2]Department of Mechanical and Aerospace Engineering, Politecnico di Torino, Turin, Italy, and [3]Department of Environmental, Land and Infrastructure Engineering, Politecnico di Torino, Turin, Italy

Aims: Atrial fibrillation (AF) patients may present ischaemic chest pain in the absence of classical obstructive coronary disease. Among the possible causes, the direct haemodynamic effect exerted by the irregular arrhythmia has not been studied in detail.
Methods and results: A computational fluid dynamics analysis was performed by means of a 1D-0D multiscale model of the entire human cardiovascular system, characterized by a detailed mathematical modelling of the coronary arteries and their downstream distal microcirculatory districts (subepicardial, midwall, and subendocardial layers). Three mean ventricular rates were simulated in both sinus rhythm (SR) and AF: 75, 100, 125 b.p.m. We conducted inter-layer and inter-frequency analysis of the ratio between mean beat-to-beat blood flow in AF compared to SR ($\overline{Q}_{AP}/\overline{Q}_{SR}$ Inter-layer analysis showed that, for each simulated ventricular rate, $\overline{Q}_{AP}/\overline{Q}_{SR}$ progressively decreased from the epicardial to the endocardial layer in the distal left coronary artery districts (P-values < 0.001 for both left anterior descending artery—LAD, and left circumflex artery—LCx), while this was not the case for the distal right coronary artery (RCA) district. Inter-frequency analysis showed that, focusing on each myocardial layer, $\overline{Q}_{AP}/\overline{Q}_{SR}$ progressively worsened as the ventricular rates increased in all investigated microcirculatory districts (LAD, LCx, and RCA) (P-values < 0.001 for all layer-specific comparisons).
Conclusions: AF exerts direct haemodynamic consequences on the coronary microcirculation, causing a reduction in microvascular coronary flow particularly at higher ventricular rates; the most prominent reduction was seen in the subendocardial layers perfused by left coronary arteries (LAD and LCx).

179 ICD or not ICD? A difficult choice for a young patient presenting with palpitations in emergency department

Maria Teresa Savo[1], Elisa Balducci[2], Vittorio Calzolari[2], and Carlo Cernetti[2]
[1]Università degli Studi di Padova, Italy, and [2]Ospedale Ca' Foncello Treviso—Marca Trevigiana ULSS 2, Italy

A fit-and-well 52-year-old worker, with negative familiar story, was admitted to Emergency Department (ED) with haemodynamically unstable but well bore broad complex tachycardia of 180 b.p.m. (Figure 1). Twenty years before the patient had heart-surgery to repair atrial septal venous sinus defect with patch. The defect determined anomalous pulmonary venous return in right atrium with left to right shunt and moderate pulmonary hypertension. The surgery, 20 years before, was complicated by a single event of supraventricular tachycardia pharmacology resolved. Next follow-up was normal although at transthoracic echocardiography severe right ventricular (RV) dilation was reported. In the ED the patient had palpitation but not chest pain or dyspnoea. General clinical examination was normal but he was hypertensive (170/137 mmHg) and with heart rate of 180 b.p.m. Valsalva manoeuver was performed and adenosine (6 mg–12 mg–12 mg) was administered without benefit. Eventually, the patient was cardioverted to sinus rhythm with a single 100 J shock. His baseline ECG (Figure 2) showed sinus rhythm, normal axis, as well as right bundle branch block and T-wave inversion in leads V1-V4 and a waves with a small spike upward in lead V1 which represent characteristic epsilon waves.
Successively patient was admitted to Cardiology Department where transthoracic echocardiography showed severe RV dilation and moderate hypokinesia with a



179 Figure 1 ECG in ED.

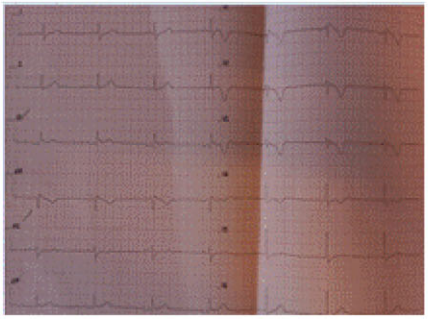


Figure 2 Baseline ECG.

Figure 3 Cardiac MRI.

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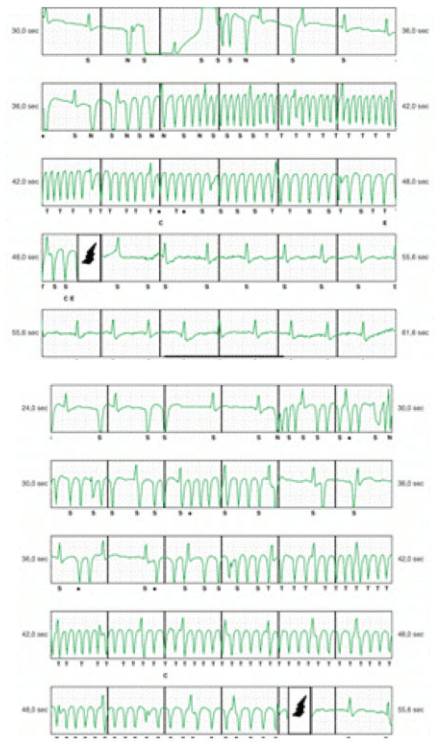
tricuspid annular plane excursion of 15 mm, TAV 9.6 cm/s, fractional area change of 29%. The right atrium was moderate dilated (volume 70 ml, indexed volume 35.53 ml/m^2). Left chambers were normal. No shunts were observed. An electrophysiology study with isoprenaline infusion was performed but no arrhythmias were induced. Cardiac magnetic resonance imaging (MRI) was normal save for global RV dilatation, increased RV end diastolic volume (156 ml/m^2), and global RV systolic dysfunction (reduction of RV ejection fraction 31%). Arrhythmogenic cardiomyopathy was excluded as patient's background suggested RV dilation was due the overload caused by the history of left-right shunt. Blood tests and personal history negative initially exclude myocarditis and cardiac MRI confirmed the absence of oedema. An accurate ECG analysis excluded Brugada syndrome. Following discussion between electrophysiologists, clinical cardiologists, and the patient who first need to be informed, trans-venous ICD was implanted.

537 Oversensing due to micro-air bubbles leading to inappropriate shocks in patient with subcutaneous implantable cardioverter defibrillator

Francesca Seganfreddo, Michele Golino, Francesca Ceriani, Federica Matteo, Matteo Morello, Claudio Licciardello, Jacopo Marazzato, Manola Vilotta, Fabrizio Caravati, and Roberto De Ponti
Department of Heart and Vessels, University of Insubria, Varese, Italy

Aims: Subcutaneous air has been reported as uncommon cause of early device malfunction after implantation of subcutaneous implantable cardioverter defibrillator (S-ICD).
Methods and results: A 43-year-old man was admitted to our hospital due to syncopal episodes. During a brain computed tomography (CT), he was resuscitated from cardiac arrest due to ventricular fibrillation. Further investigations excluded ischaemic heart disease and cardiac magnetic resonance showed signs of prior myocarditis. After successful screening, an S-ICD was inserted for secondary prevention using the standard technique. The chest X-ray excluded acute post-procedural complications. Three days after implantation, he experienced two inappropriate shocks while conscious. Device interrogation revealed frequent high-amplitude signals followed by two shocks (Figure 1A and B) that could be interpreted as oversensing. During provocative maneuvers on the generator case, minimal and intermittent noise only on the secondary sensing vector was observed. Lateral and antero-posterior chest X-ray excluded subcutaneous air. However, the general agreement based on previous reports was that oversensing as observed in Figures 1A and B was typical for noise due to micro-air bubbles in the connection between the lead and the generator case. As a consequence, the sensing vector was successfully changed and no other inappropriate shocks were observed during follow-up.

Fig. 1A



Conclusions: Entrapped micro-air bubbles in the connection between the leads and the generator case can cause inappropriate shocks in the early period after S-ICD implantation. Timely recognition of this complication is important to prevent inappropriate shocks. It can occur shortly after the procedure even if the intra-procedural parameters were normal and chest X-ray excluded acute complications. As demonstrated in our case, the device can be reprogrammed using another sensing vector to solve these oversensing problems.

178 Catheter inversion during cavotricuspid isthmus catheter ablation: the new shaft visualization catheter reduces fluoroscopy use

Nicolò Sisti, [1]Amato Santoro[1], and Claudia Baiocchi[1]
[1]Università di Siena, Italy, and [2]Ospedale San Eugenio, Roma, Italy

Aims: Catheter ablation (CA) is the choice therapy of cavotricuspid isthmus (CTI) atrial flutter. The aim of this study was to describe our approach to improve the CTI ablation using a zero-fluoroscopy (ZF). The procedural difficulties could be related to anatomical characteristics of the CTI.
Methods and results: One hundred eighty-eight patients that performed CA of CTI were retrospectively and consecutively evaluated between 2017 and 2019. The studied population was divided into two groups. Eighty-eight patients who were undergone CA using ablation catheter without shaft visualization catheter (NSV) were Group 1. One hundred patients were undergone CA using ablation catheter with a shaft visualization (SV); they were Group 2. The catheter was looped at the Eustachian ridge after 200 s of radiofrequencies (RF) without elimination of local electrogram. A conduction line block of CTI was obtained in all patients of Group 2 using a ZF approach. In 16 patients of Group 1, the catheter inversion was obtained using fluoroscopy to avoid damages during its loop. In Group 2, a complete CTI block was obtained with a catheter inversion approach in 10 patients without fluoroscopy, visualizing the shaft and the tip of the ablation catheter on the electroanatomic (EAM) map. In the overall population studied the use of SV had a linear correlation with the ZF approach ($r = 0.629$; $P < 0.001$). The duration of RF was lower in Group 2 than in Group 1 (Group 1: 27.8 ± 6.3 vs. Group 2: 15.6 ± 7.2 min; $P < 0.01$). The procedure time between two groups was lower in Group 2 than in Group 1 (Group 1: 58.4 ± 22.4 vs. Group 2: 42.2 ± 15.7 min; $P < 0.01$). No differences between two groups were documented regarding success and complications.
Conclusions: The visualization of the shaft's catheter on the EAM permitted the catheter inversion safely in order to overcome some complex CTI anatomy and obtain bidirectional block. The SV reduced procedure time, RF applications, and fluoroscopy exposition during CTI ablation.

549 The role of conventional and speckle tracking echocardiography in the evaluation of leadless endocardial pacing with Micra-AV

Nicolò Soldato[1], Nicola Bozza[1], Paolo Basile[1], Gianluca Pontone[2], Paola Siena[1], Riccardo Memeo[1], Vincenzo Ezio Santobuono[1], Maria Cristina Carella[1], Stefano Favale[1], and Andrea Igoren Guaricci[1]
[1]Cardiologia Universitaria Policlinico di Bari, Italy, and [2]Centro Cardiologico Monzino, IRCCS, Milano, Italy

Aims: Micra-AV pacing system is a leadless pacemaker (LP) implanted in the right ventricle which can provide atrio-ventricular (AV) synchronous pacing. Echocardiographic data assessing left ventricle contractility 24–48 h after Micra AV implantation are lacking. To evaluate via conventional echocardiography and speckle-tracking echocardiography (STE), which was the best pacing modality (VVI vs. VDD) able to ensure the most efficient hemodynamic performance assessed by left ventricle ejection fraction (LF-EF) and global longitudinal strain (GLS).
Methods and results: We studied nine patients with high degree AV-block, enrolled in our Institution in a range of time of 5 months. All patients had first degree AV block (PQ interval between 160 and 340 ms). They were considered suitable candidates for MICRA-AV implantation according to current guidelines. Both LF-EF and GLS were performed 24–48 h after device implantation by two experienced echocardiographic physicians. The mean age of the population was 79 ± 8 years (8 were male, 89%). Risk factors more represented were hypertension and dyslipidaemia. The maximum PQ interval was 256 ± 51 ms. VDD pacing modality allows better LV-EF values than those obtained with a VVI stimulation (with a difference that was statistically significant difference, P-value = 0.008). Similarly, we obtained better GLS values during VDD pacing as respect to VVI (P-value = 0.008).
Conclusions: Left ventricle ejection fraction and LV-GLS improve early after leadless MICRA-AV implantation during VDD as compared to VVI pacing modality.

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286 Incidence of pocket haematoma with different anticoagulation strategies in patients undergoing cardiac implantable device implant or revision

Enrico Guido Spinoni[1,2], Matteo Santagostino[2], Simona Costantino[1], Eleonora Battistini[1,2], Gabriele Dell'Era[1,2], Stefano Porcellini[2], Federica De Vecchi[2], Marco Mennuni[1,2], and Giuseppe Patti[1,2]
[1]Università del Piemonte Orientale, Novara, Italy, and [2]AOU Maggiore della Carità, Novara, Italy

Aims: Direct oral anticoagulants (DOACs) are known for lower bleeding risk than vitamin K antagonist (VKA) in patients with atrial fibrillation (AF). To date, it has not been established whether in such population DOAC may offer reduction of bleeding complication in patients undergoing cardiac implantable electronic device (CIED) implant or revision (substitution, upgrade, or downgrade). We evaluated whether DOACs compared to VKAs, decrease bleeding complications at the time of CIED implant in patients with AF, requiring oral anticoagulant therapy.
Methods and results: We present a monocentric observational retrospective study. Patients undergoing implant, generator replacement, or upgrading/downgrading of an intracardiac device (PM, ICD, or CRT) between January 2015 and March 2021 with AF undergoing DOAC or VKA were included. The comparison of risk of clinically significant pocket hematoma at 30-days follow-up in the two-treatment group [DOAC vs. VKA and DOAC vs. VKA without low molecular weight eparin (LMWH) bridge] was performed. Cox proportional hazards regression analysis including main clinical findings was performed to test the primary endpoint. Propensity score matching analysis was performed, with inversed proportional weighted (IPW) propensity score included in the multivariate analysis. 311 patients were included, 146 (46.9%) treated with DOAC and 165 (53.1%) treated with VKA. The incidence pocket haematoma was significantly reduced in patients treated with DOAC compared with VKA (3.4% vs. 13.3%, respectively, $P = 0.002$), a finding confirmed on multivariate analysis (HR: 3.02, CI: 1.10–8.29, $P = 0.032$). The incidence of pocket haematoma in patients on DOAC vs. VKA without LMWH bridge therapy was found to be significantly higher in the latter group of patients ($P = 0.033$, HR: 2.93, CI: 1.01–8.49, $P = 0.48$). After adjusting at propensity score with IPW, DOAC use showed decreased risk of pocket haematoma (HR: 0.29, CI: 0.09–0.95, $P = 0.42$).
Conclusions: In patients with atrial fibrillation undergoing CIED implant or revision, DOAC therapy appears to be associated with lower risk of event-related pocket haematoma at 30-day follow-up, even in the absence of bridging with LWMH. Such findings are hypothesis-generating.

153 Fragmented QRS in athletes

Goffredo Orlandi, Lorenzo Casatori, Marco Corsi, Loira Toncelli, Maria Boddi, Pietro Amedeo Modesti, and Laura Stefani
Sports Medicine Center, University of Florence, Italy

Aims: Fragmented QRS (fQRS), defined as the presence of additional peaks within the QRS complex (<120 ms) in at least two contiguous leads, was considered as a pattern of fibrosis. However, fQRS can also be detected during pre-participation cardiovascular screening. To assess determinants of fQRS in athletes of different sports.
Methods and results: Retrospective study conducted on 605 non-sedentary subjects undergoing pre-participation cardiovascular screening for competitive activity in six disciplines (athletics, football, cycling, swimming, basketball, and volleyball). All subjects underwent ECG for the search of fQRS and transthoracic echocardiography. Predictors of fQRS were investigated using multivariate logistic analysis adjusted for. fQRS was found in 47 of 605 subjects. On multivariate logistic analysis, fQRS was positively associated with age (OR: 1.03; 95% CI: 1.01–1.05), male sex (OR: 0.35; 95% CI: 0.13–0.94), whereas no association with sport discipline was observed (0.91; 0.73–1.12). When echocardiographic parameters were considered, fQRS was associated with cardiac mass index (OR: 1.02; 95% CI: 1.00–1.03) and E wave (OR: 0.98; 95% CI: 0.96–0.99).
Conclusions: At pre-participation cardiovascular screening, the fQRS finding increases with age, is more frequent in males, and seems to be independent from practiced sport. Furthermore, fQRS in athletes appears to be associated with parameters of physiological hypertrophy (LV cardiac mass index and diastolic function).

726 Outcomes of ischaemic stroke in patients with atrial fibrillation

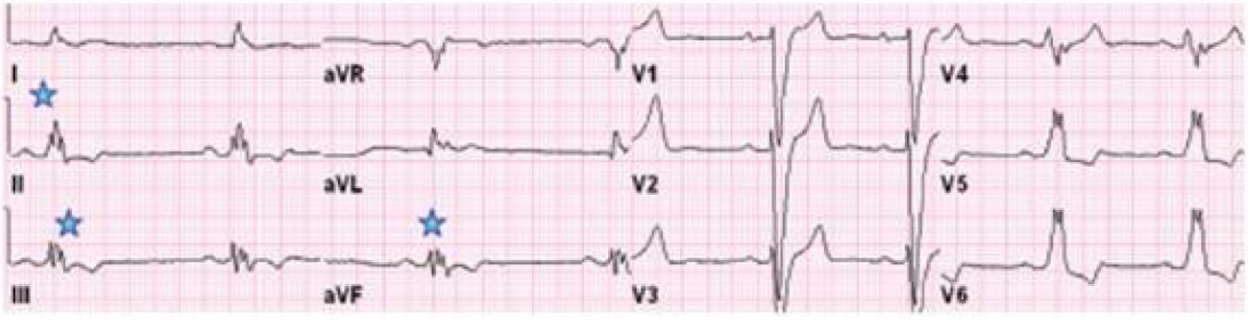
Teresa Strisciuglio, Valerio Pergolae, Giuseppe Ammirati, Lucio Addeo, Gaetano Todde, Giovanni Esposito, and Antonio Rapacciuolo
Università degli Studi di Napoli Federico II, Italy

Aims: Atrial fibrillation (AF) increases the risk of ischaemic strokes (IS) and is associated with a more severe neurological impairment. We sought to investigate whether AF also impacts the neurological recovery and whether patients with AF have a different response to the treatment.
Methods and results: Data of patients admitted to the Stroke Unit of our institution from January to December 2020 were retrieved from the local database. The stroke severity was calculated by mean of the National Institute of Health Stroke Scale (NIHSS) at hospital admission ($NIHSS_{ad}$), at 24 h ($NIHSS_{24}$) and at discharge ($NIHSS_{dis}$). The functional capacity was assessed by the modified Rankin score (mRS). As for the neurological recovery, this was assessed by the delta NIHSS at 24 h ($\Delta_{24} = NIHSS_{24} - NIHSS_{ad}$) and at discharge ($\Delta_{dis} = NIHSS_{dis} - NIHSS_{ad}$). Out of 545 patients with IS 64 had known history of AF or were admitted with AF. Patients with AF had higher $NIHSS_{ad}$ (13.9 ± 7 vs. 8.5 ± 7; $P < 0.001$) and $NIHSS_{24}$ (9.6 ± 8 vs. 6.4 ± 7; $P = 0.007$) than patients without, however the neurological improvement was greater (Δ_{dis} -7.4 ± 9 vs. -3.4 ± 6; $P = 0.002$), indeed the $NIHSS_{dis}$ was similar (4.2 ± 5 vs. 4.2 ± 6; $P = 0.98$). Patients with AF also had a more impaired mRS before the ischaemic event and at discharge (2.4 ± 1.9 vs. 1.6 ± 1.7, $P = 0.02$; 1.2 ± 1.2 vs. 0.4 ± 0.9, $P < 0.001$). Among AF patients with CHADVASC ≥ 3, 34% of them were taking antiplatelet therapy, 31% anticoagulants, and 35% didn't take any therapy. Of interest, no differences in the $NIHSS_{ad}$ nor in the $NIHSS_{dis}$ were found between them and neither in the Δ_{dis}. As for the treatment of AF patients, no differences in the neurological recovery were observed between those treated with intravenous thrombolysis and those not treated at all (Δ_{dis} 2.8 ± 5 vs. 2.8 ± 8, $P = 1$), whereas the Δ_{dis} was significantly higher in patients treated with mechanical thrombectomy (-11.7 ± 7, $P = 0.007$).
Conclusions: Patients with AF experience more severe stroke, however the neurological recovery is greater than in patients without the arrhythmia. The treatment with antiplatelets or anticoagulants before the event does not reduce the severity of the stroke and does not influence the improvement of the NIHSS at discharge. The mechanical thrombectomy is more effective in reducing the neurological impairment.

522 A strange case of bradycardia in a 38-year-old woman postpartum

Gianmarco Bastianoni, Federico Paolini, Giulia Stronati, Michela Casella, Dello Russo Antonio, and Federico Guerra
Clinica di Cardiologia e Aritmologia 'Ospedali Riuniti' Ancona, Italy

Methods and results: A 38-year-old woman at her 4th day postpartum from a twin pregnancy, presented to the Emergency Room with general malaise, headache, and dyspnoea. Her symptoms had started to show 2 days prior to her ER admission and were worsened by bilateral pitting oedema. In particular they had started when she



Definition of fQRS :Presence of one or more additional R waves (R') or of a notch in the S wave in at least 2 contiguous leads in the event of a wide QRS (≥ 120 ms), more than two notches or more than two additional R 'waves must be found, in at least 2 contiguous leads.
In this case we speak of fragmented wide QRS (f-wQRS)

153 Figure

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was administered cabergoline to suppress lactation. Her blood pressure was elevated (160/80 mmHg) and her heart rate was 40 b.p.m. On examination she was oriented in time and space. Her laboratory exams showed anaemia (Hb 8.8 g/dl), with negative D-dimer and troponin. She had no urine proteinuria, which allowed pre-eclampsia to be excluded from the diagnostic hypotheses. A 12-lead ECG was performed and showed junctional rhythm with isorhythmic dissociation at 40 b.p.m. She was admitted to the cardiology ward for diagnostic workup. Her echocardiogram showed no structural alteration and preserved ejection fraction. A cardiac magnetic resonance confirmed the absence of structural alterations or late gadolinium enhancement. During her hospital stay, sinus rhythm was spontaneously restored at 42 b.p.m.; in addition to this, restoration of sinus rhythm, although bradycardic, was associated to the resolution on both her symptoms and of her pitting oedema. She was discharged with a diagnosis of bradycardia secondary to carbegoline use. Her Holter ECG, performed 7 days after discharge, showed sinus bradycardia with occasional isorhythmic dissociation.

Conclusions: Cabergoline is an ergot-derived dopamine agonist usually used in the treatment of Parkinson's disease. It acts selectively on D2 receptors. It can be associated to orthostatic hypotension, cardiac valvular fibrosis, and angina pectoris. No cases of cabergoline-induced bradycardia can be currently found in literature; however, a similar effect was seen with the use of methylergometrine in a women during her post-partum period. Furthermore, studies on mice have shown that ergot derivatives may cause reduction of heart rate. It therefore seems possible that in our case, the use of cabergoline induced the patient's bradyarrhythmia.

235 Ventricular arrhythmias and cardiac autonomic function in patients with severe aortic valve stenosis before and after transcatheter aortic valve implantation

Alessandro Telesca, Eleonora Gnan, Antonio De Vita, Saverio Tremamunno, Tamara Felici, Salvatore Emanuele Ravenna, Crea Filippo, and Gaetano Antonio Lanza
Department of Cardiovascular Medicine, Fondazione Policlinico Universitario A. Gemelli IRCCS, Università Cattolica del Sacro Cuore, Rome, Italy

Aims: Transcatheter aortic valve implantation (TAVI) has become a first-line treatment for most patients with severe aortic stenosis (AS) at intermediate/high surgical risk, resulting in significant improvement of clinical outcome. However, whether ventricular arrhythmias (VAs) or cardiac autonomic dysfunction influence outcome and whether TAVI has any effects on VAs and cardiac autonomic function is unknown. Thus, this study was aimed to investigate: I1) whether VAs and autonomic dysfunction [as assessed by heart rate variability (HRV)] are associated with clinical outcome and (2) the effects of TAVI on VAs and HRV, in patients with severe AS.

Methods and results: We studied 71 consecutive patients with severe aortic stenosis, admitted to our department of Cardiovascular Medicine to undergo TAVI. Patients with previous cardiac surgery, percutaneous coronary revascularization, acute coronary syndrome, and other significant heart valve disease or relevant comorbidities were excluded. The day before TAVI all patients underwent transthoracic Doppler echocardiography (TTDE), including global longitudinal strain (GLS) assessment, and 24-h ECG Holter monitoring (HM), to assess VA burden and HRV. A clinical follow-up was performed at 6 months from discharge. Furthermore, TTDE and 24-h HM were performed at follow-up in 38 (54.5%) and 29 (40.8%) patients, respectively. The primary endpoint was the occurrence of major clinical events (MACE), that include death, hospitalization for cardiac causes, pacemaker implantation, myocardial infarction, or stroke. Of 71 patients (48 female, mean age 80.5 ± 6.5 years) enrolled in the study, a 6-month clinical follow-up could be performed in 54 (76%). MACE occurred in 21 patients (38.9%), 8 of whom (14.8%) had hospitalization for heart failure, 13 (24%) required pacemaker implantation, and 3 had stroke (5.6%). Compared to baseline, at follow-up the mean aortic valve gradient (50.6 ± 11.4 vs. 8.38 ± 3.23 mmHg, $P < 0.001$), left ventricle (LV) mass index (131.4 ± 38.9 vs. 112.9 ± 28.3 g, $P = 0.007$), pulmonary artery systolic pressure (37.3 ± 5.8 vs. 30.2 ± 9.8 mmHg; $P < 0.001$), and the ratio of Doppler transmitral early filling velocity to tissue-Doppler early diastolic mitral annular velocity (E/e') (16 ± 5.3 vs. 13.2 ± 4.7 $P < 0.001$) were significantly reduced. In contrast no changes were observed in VAs. The number of premature ventricular complexes (PVCs) at HM was indeed 1062 ± 3833 vs. 1206 ± 3322 at follow-up and baseline, respectively ($P = 0.11$). Furthermore, PVCs >10 per hour were detected in a higher number of patients at 6-month follow-up, compared to baseline (23.8% vs. 45.2%; $P = 0.022$). No significant differences were detected in most time-domain and frequency-domain HRV parameters. Unexpectedly, SDNNi (62.8 ± 19.1 vs. 41.9 ± 16.5; $P = 0.008$), RMSSD (54.6 ± 36.6 vs. 30.1 ± 17.9; $P = 0.024$) and VLF (56.4 ± 49.6 vs. 29 ± 12.7; $P = 0.028$) were found to be significantly higher at follow-up compared to baseline.

Conclusions: Our data show that, in patients with severe AS, TAVI does not seem to have significant effects on VA burden, despite echocardiographic and clinical improvement. Similarly, our data failed to show significant improvement of sympathovagal balance at follow-up compared to baseline in these patients.

471 Arrhythmia-free survival in early-persistent atrial fibrillation patients undergoing radiofrequency catheter ablation

Michele Magnocavallo[1,2], Domenico Giovanni Della Rocca[2], Carlo Lavalle[1], Cristina Chimenti[1], Gianni Carola[2], Sanghamitra Mohanty[2], Chintan Trivedi[2], Mohamed Bassiouny[2], Amin Al-Ahmad[2], David J Burkhardt[2], Joseph G Gallinghouse[2], Javier E Sanchez[2], Rodney P. Horton[2], and Andrea Natale[2]
[1]Department of Cardiovascular, Respiratory, Nephrological, Anesthesiological and Geriatric Sciences, 'Sapienza' University of Rome, Policlinico Umberto I, 000161 Rome, Italy, and [2]Texas Cardiac Arrhytmia Institute, ST. David's Medical Center Austin, TX 78705, USA

Aims: Despite advances in success rate of paroxysmal atrial fibrillation (PAF) ablation, outcomes of radiofrequency catheter ablation (RFCA) in patients with persistent AF are highly variable. Early persistent AF (EPsAF) is defined as AF that is sustained beyond 7 days but is less than 3 months in duration. Arrhythmia-free survival data after RFCA in this specific population are still limited. We sought to report the outcomes of RFCA in the subgroup of patients with EPsAF, compared to those with PAF and with 'late' persistent AF (LPsAF) lasting between 3 and 12 months.

Methods and results: Data from 1143 consecutive AF patients receiving their first RFCA were prospectively collected. Patients with EPsAF ($n = 190$) were compared with PAF ($n = 531$) and LPsAF ($n = 422$) patients. All patients received pulmonary vein antrum isolation + posterior wall and sustained non-pulmonary vein (PV) trigger ablation. Non-sustained non-PV triggers were ablated based on operator discretion. Non-PV triggers were defined as sites of firing leading to sustained (>30 s) or non-sustained arrhythmias (<30 s, including premature atrial contractions ≥10 beats/min) with earliest activation outside the PVs. Mean age of the population was 64 ± 11 years. Female patients were more in PAF group (39%) compared to EPsAF (26%) and LPsAF (28%) ($P < 0.001$). There was no difference in other clinical characteristics among populations. Non-PV triggers were detected more in EPsAF [127 (66.8%)], and LPsAF [296 (70.1%)] patients compared to PAF [185 (34.8%)] ($P < 0.001$).One-year arrhythmia-free survival rate after a single procedure was 75.0% (398), 74.2% (141), and 64.5% (272) in PAF, EPsAF, and LPsAF, respectively. Success rate was significantly higher in PAF {[HR: 0.67 (0.53, 0.84), $P = 0.001$] and EPsAF [HR: 0.67 (0.49, 0.93)], $P = 0.015$} compared to LPsAF.

Conclusions: In patients with EPsAF, RFCA may result in significantly better freedom from atrial arrhythmias, compared to LPsAF. In this cohort, ablation might be reasonable as first line approach to improve outcomes and prevent AF progression.

473 Propensity-matched comparison of left atrial appendage occlusion and direct oral anticoagulation for thromboembolic prevention in octogenarians

Michele Magnocavallo[1,2], Domenico Giovanni Della Rocca[2], Carlo Lavalle[1], Cristina Chimenti[1], Gianni Carola[2], Sanghamitra Mohanty[2], Chintan Trivedi[2], Mohamed Bassiouny[2], Amin Al-Ahmad[2], David J Burkhardt[2], Joseph G Gallinghouse[2], Javier E Sanchez[2], Rodney P Horton[2], and Andrea Natale[2]
[1]Department of Cardiovascular, Respiratory, Nephrological, Anestesiological and Geriatric Sciences, 'Sapienza' University of Rome, Policlinico Umberto I, 00161 Rome, Italy, and [2]Texas Cardiac Arrhytmia Institute, ST. David's Medical Center, Austin, TX 78705, USA

Aims: A significant amount of atrial fibrillation patients does not receive appropriate anticoagulation, owing to contraindications and side effects. Octogenarians have higher competing comorbidities with a remarkable bleeding/thromboembolic (TE) risk. We aimed at analysing the clinical outcomes of LAAO compared with direct oral anticoagulation (DOAC) in octogenarians.

Methods and results: Data were extracted from two prospective databases including 488 LAAO and 825 DOAC patients. Patients aged 80 years or older accounted for 37.1% ($n = 181$) and 39.5% ($n = 326$). In order to attenuate the imbalance in covariates between the groups, a propensity score matching technique was used (covariates: age, sex, CHA2DS2-VASc, and HAS-BLED scores, follow-up duration; tolerance 0.02). This method resulted in matched populations with 108 octogenarian patients per group. The annual stroke/transient ischaemic attack (TIA) risk was estimated based on the CHA2DS2-VASc, and compared to the annualized observed risk, owing to calculate the % risk reduction associated with the two treatment strategies. A total of 216 octogenarians were included in the analysis (84 ± 3 years; CHA2DS2-VASc: 4.9 ± 1.4, HAS-BLED: 3.1 ± 0.9). A Watchman device was successfully deployed in all LAAO ≥ 80 patients; periprocedural adverse events were observed in 2.8% ($n = 3$) of LAAO patients. During a follow-up of 13 ± 4 months, 3 (2.8%) TE complications (1 stroke, 2 TIA) occurred in LAAO ≥ 80 pts and 4 (3.7%; 1 stroke, 3 TIA) in DOAC ≥ 80 pts ($P = 0.99$). The annualized risk of stroke/TIA was 2.5% in the first and 3.5% in the second group. Based on the estimated annual TE risk according to the CHA2DS2-VASc score, the % risk reduction after LAAO and DOAC was 54.5% and 36.4%, respectively. Major bleeding events were 3 [1 intracranial, 2 gastrointestinal (GI)] LAAO ≥ 80 pts, and 3 (2 intracranial, 1GI) in DOAC ≥ 80 pts (2.8% in both groups). Minor bleeding events were significantly higher in DOAC ≥ 80 pts [13.0% ($n = 14$) vs. 2.7% ($n = 3$); RR: 4.7, 95% CI: 1.4-15.7; $P = 0.009$].

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Conclusions: LAAO was safe and similar to DOAC at preventing ischaemic/major bleeding events in a matched population of patients aged ≥80 years. A significantly higher incidence of minor bleeding events was observed in the DOAC group.

616 Endocardial lead placement guided by high resolution voltage mapping in a patient with recurrent failure of transvenous pacing system

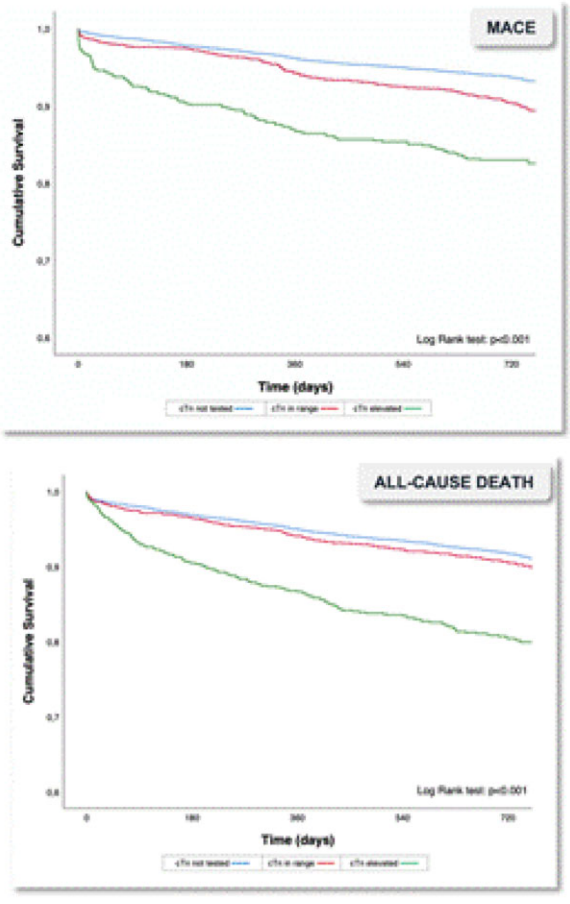
Paolo Vitillo[1,2], Francesca Esposito[1], Francesco Rotondi[1], Felice Nappi[1], Francesco Urraro[1], Angela Laurino[1], Anna Russo[1], Filomena Colimodio[3], and Emilio Di Lorenzo[1]
[1]Cardiologia-UTIC D. Rotiroti, Azienda Ospedaliera di Rilievo Nazionale, San Giuseppe Moscati, Avellino, Italy, [2]Scuola di Specializzazione in Malattie Dell'Apparato Cardiovascolare, Università degli Studi Salerno, Italy, and [3]Azienda Ospedaliera San Giovanni Bosco, Napoli, Italy

Methods and results: A 58 years-old man was admitted to our intensive care unit for syncope due to inconstant capture of epicardial ventricular lead. His cardiovascular history began 20 years before when he underwent single chamber pacemaker implantation with insertion of a passive fixation ventricular lead for symptomatic complete atrio ventricular block (AVB). Electrical parameters were good at implantation. However, during follow-up a gradual and progressive increase of pacing threshold occurred, with no changes in impedance values, finally leading to complete loss of ventricular capture. Hence, 2 years later, the lead was extracted and a new transvenous ventricular lead was placed in septal position. All electrical parameters were optimal at the end of the procedure. However, in the following months threshold values gradually increased as previously observed. The referring clinicians decided to surgically extract both the device and transvenous lead and to implant an epicardial ventricular lead connected to an abdominal generator. The pacemaker worked properly for about 17 years until he was transferred to our institution with evidence of inconstant lead capture at maximum pacing outputs. A temporary transvenous pacemaker was immediately inserted. Clinical examination, laboratory exams, and echocardiography were normal. Cardiac magnetic resonance (MRI) was not feasible due to the epicardial lead. Thus, in order to obtain cardiac substrate characterization, we decided to perform high density multielectrode voltage mapping of the right ventricular endocardium with HD Grid multielectrode mapping catheter (HD Grid mapping catheter sensor enabled, Abbott Technologies, Minneapolis, MN). Electroanatomic voltage map allows distinction of areas of healthy myocardium (>1.5 mV) from scar tissue (<0.5 mV). Unexpectedly, voltage mapping highlighted no scar zones, showing a globally normal endomyocardial surface. Therefore, a new endocavitary pacemaker was inserted in right prepectoral region and an active fixation right ventricular lead was placed on mid-ventricular septum. A backup pacing lead was placed in a more apical position in an area of endocardial healthy myocardium. Post-procedural sensing, impedance and capture threshold were optimal (0.3 V × 0.4 ms for mid-septal lead and 0.3 × 0.4 ms for the other one). At 1 month follow-up mid-septal lead's threshold was slightly increased (1.0 V × 0.4 ms) and further increase was observed at 3-month outpatient visit (1.75 V × 0.4 ms). Capture threshold of the other lead and other parameters were stable. The patient received remote monitoring for home surveillance of the implanted system. Home monitoring shows a trend toward a progressive increase of pacing threshold of the mid-septal lead and stable value of the other electrode.
Conclusions: The present report suggests an innovative use of high-density mapping with HD Grid catheter to characterize endocardial right ventricular myocardium in a patient with contraindication to cardiac MRI and recurrent failure of previous implanted pacing systems for unknown reason and to guide effective lead placement in areas of normal endocardial voltage. Combined use of telemedicine and high-resolution mapping technique allowed us to avoid unnecessary high risk reintervention for novel epicardial lead placement.

684 Cardiac troponins and adverse outcomes in European patients with atrial fibrillation: a report from the ESC-EHRA EORP atrial fibrillation general long-term registry

Marrco Vitolo[1], Vincenzo Livio Malavasi[1], Marco Proietti[2], Igor Diemberger[3], Laurent Fauchier[4], Francisco Marin[5], Michael Nabauer[6], Tatjana Potpara[7], Gheorghe-Andrei Dan[8], Zbigniew Kalarus[9], Luigi Tavazzi[10], Aldo Pietro Maggioni[11], Deirdre A. Lane[12], Gregory Y.H. Lip[12], and Giuseppe Boriani[1]
[1]Cardiology Division, Policlinico di Modena, University of Modena and Reggio Emilia, Italy, [2]University of Milan, Italy, [3]University of Bologna, Italy, [4]University of Tours, France, [5]University of Murcia, Spain, [6]University of Munich, Germany, [7]University of Belgrade, Serbia, [8]University of Bucharest, Romania, [9]University of Silesia, Poland, [10]Maria Cecilia Hospital, GVM Care and Research, Cotignola, Italy, [11]ANMCO Research Center, Firenze, Italy, and [12]Liverpool Centre for Cardiovascular Science, University of Liverpool, UK

Aims: Cardiac troponins (cTn) have been reported to be predictors for adverse outcomes in atrial fibrillation (AF), patients, but their actual use is still unclear. To assess the factors associated with cTn testing in routine clinical practice and to evaluate the association of elevated levels of cTn with adverse outcomes in a large contemporary cohort of European AF patients.
Methods and results: Patients enrolled in the ESC-EHRA EORP-AF General Long-Term Registry were stratified into three groups according to cTn levels as (i) cTn not tested, (ii) cTn in range (≤99th percentile), and (iii) cTn elevated (>99th percentile). The composite outcome of any thromboembolism/any acute coronary syndrome (ACS)/cardiovascular (CV) death, defined as major adverse cardiovascular events (MACE) and all-cause death were the main endpoints. 10 445 (94.1%) AF patients were included in this analysis [median age 71 years, interquartile range (IQR): 63–77; males 59.7%]. cTn were tested in 2834 (27.1%). Overall, cTn was elevated in 904 (8.7%) and in-range in 1930 (18.5%) patients. Patients in whom cTn was tested tended to be younger ($P < 0.001$) and more frequently presenting with first detected AF and atypical AF-related symptoms (i.e. chest pain, dyspnoea, or syncope) ($P < 0.001$). On multivariable logistic regression analysis, female sex, in-hospital enrollment, first-detected AF, CV risk factors, history of coronary artery disease (CAD), and atypical AF symptoms were independently associated with cTn testing. After a median follow-up of 730 days (IQR: 692–749), 957 (9.7%) composite endpoints occurred while all-cause death was 9.5%. Kaplan-Meier analysis showed a higher cumulative risk for both outcomes in patients with elevated cTn levels (Figure) (Log Rank tests, $P < 0.001$). On adjusted Cox regression analysis, elevated levels of cTn were independently associated with a higher risk for MACE [hazard ratio (HR): 1.74, 95% confidence interval (CI): 1.40–2.16] and all-cause death (HR 1.45, 95% CI: 1.21–1.74). Elevated levels of cTn were independently associated with a higher occurrence of MACE, all-cause death, any ACS, CV death and hospital readmission even after the exclusion of patients with history of CAD, diagnosis of ACS at discharge, those who underwent coronary revascularization during the admission and/or who were treated with oral anticoagulants plus antiplatelet therapy.
Conclusions: Elevated cTn levels were independently associated with an increased risk of all-cause mortality and adverse CV events, even after exclusion of CAD patients. Clinical factors that might enhance the need to rule out CAD were associated with cTn testing.



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