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Recurrent Hemoptysis in a 30-Year-Old Female with Ebstein's Anomaly and a Prior History Epicardial ICD Patches: Status Post Orthotopic Heart Transplant

By Tabitha Moe, MD; Andrew Kao, MD; Anthony Magalski, MD

Introduction

Ebstein's Anomaly of the Tricuspid Valve is rare and comprises less than one percent of all congenital heart defects.[1] It was first described by Wilhelm Ebstein in 1866 during the autopsy of a 19-year-old who had had palpitations and dyspnea since childhood.[2] The description was accompanied by meticulous hand-drawn illustrations demonstrating:

a. a severe malformation of the tricuspid valve;
b. absence of the valve to the coronary sinus, and;
c. a patent foramen ovale.[3,4]

The anatomical defect is a result of failed apoptosis of tricuspid tissue during embryonic development resulting in adherence to the underlying myocardium. The tricuspid leaflets are displaced towards the apex causing atrialization of the right ventricle.[1] Ebstein's Anomaly demonstrates a wide spectrum of phenotypic presentations including marked functional impairment of the RV with tricuspid regurgitation and extreme dilatation of both right atria and RV. Despite the potential for RV enlargement in this group, right-sided pressures typically remain low, and the incidence of VT and SCA are also typically quite low.[5,6] Therefore, ICD implantation in this group remains tailored to the individual. Patients with Ebstein's who present with concomitant left ventricular (LV) abnormalities, specifically non-compaction of the LV, may also have ventricular arrhythmias. Ventricular arrhythmias are most commonly associated with SCA, as in this case. In the last 30 years ICD implantation has progressed from a surgical approach to a transvenous approach.[10] Despite the ease of ICD implantation, its use can be complicated by: pericardial tamponade,

"Ebstein's Anomaly demonstrates a wide spectrum of phenotypic presentations including marked functional impairment of the RV with tricuspid regurgitation and extreme dilatation of both right atria and RV."

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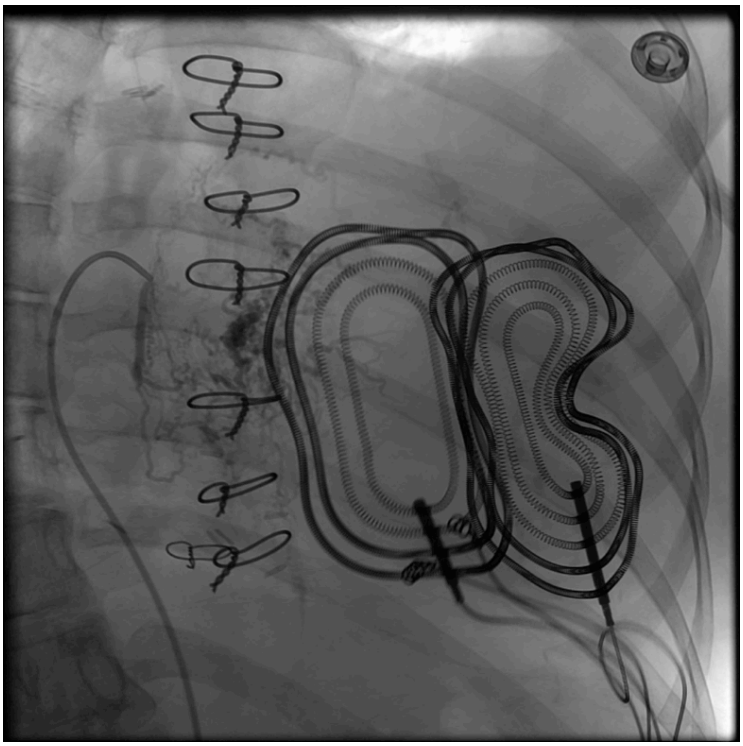


Image 1. CT Chest May 2010 - Second episode of hemoptysis. Please note the crinkling of the anterior ICD patch consistent with prior reports of post-OHT patch retention.[9]

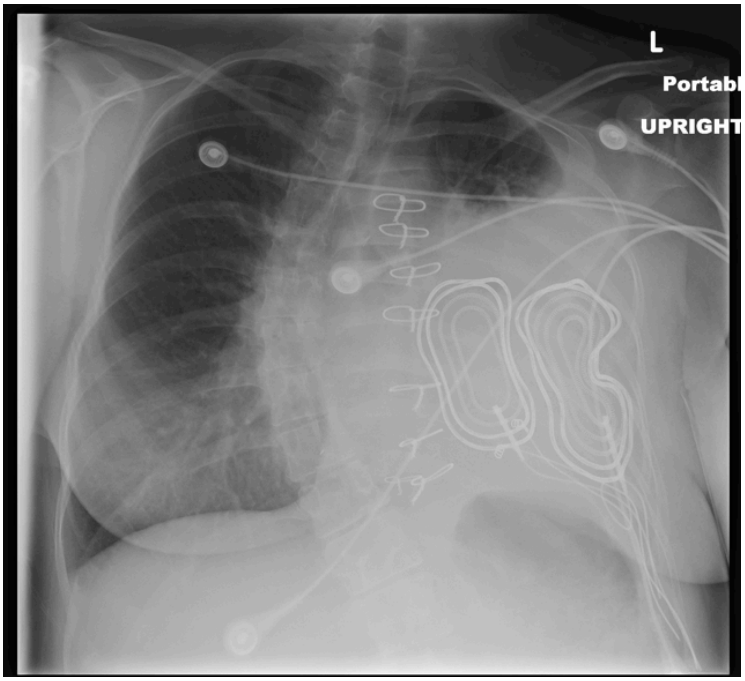


Image 2. Chest x-ray 12-31-10 Final episode of hemoptysis. The left-sided opacification has progressed over time with complete atelectasis of the left lung.

pocket hematoma, seroma, wound infection, device migration, lead fracture, RV perforation, pneumothorax and hemoptysis. The current report details another possible complication of an ICD patch following OHT.

Case Report

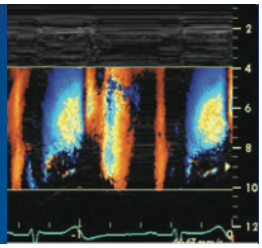
A 30-year-old female with Ebstein's anomaly 2 years post orthotopic heart transplant (OHT) presented with an 18 month history of recurrent hemoptysis. Her past surgical history includes: ventricular septal defect repair in 1984, with subsequent porcine tricuspid valve replacement in 1994, placement of epicardial defibrillator (ICD) patch electrodes and abdominal generator in 1995, at the age of 15 for sudden cardiac arrest (SCA). She underwent OHT in January 2009 for intractable right ventricular (RV) dysfunction. The epicardial leads could not be removed at that time due to the complexity of a third-time redo sternotomy.

On post-operative Day 6, she had minimal epistaxis, and underwent bronchoscopy, which did not reveal any endobronchial lesions; no endobrochial vessels were appreciated. She presented on three occasions with severe hemoptysis in March 2009, May 2010, and finally, January 2011. She nearly exsanguinated with her initial presentation, and required bronchial artery embolisation for management of her acute episode of bronchoalveolar collateral hemorrhage. Chest CT at that time demonstrated progression of atelectasis of the left lower lobe. Bronchoscopy revealed a large clot in the left mainstem bronchus which could not be aspirated, as there was continued oozing around the thrombus.

The second episode was mild and resolved spontaneously. At the time of her third episode, she hemoptysized approximately ½ cup of bright red blood and was admitted directly from the clinic to the interventional suite. Initial exam revealed the patient to be hypotensive, pale, and diaphoretic. She had complete absence of left-sided breath sounds, with clear breath sounds throughout the right lung. A chest x-ray showed persistent complete opacification of the left hemithorax. CT angiography demonstrated a blush consistent with collateralization of the left bronchial artery. She underwent embolisation of the left bronchial artery, and left thoracic arteries T-7 through 9. She continued to have hemoptysis despite embolisation, and was intubated to protect the right lung. She was subsequently taken to the operating room for a left total penumonectomy and removal of the embedded epicardial leads. According to the operative report the lateral epicardial patch was found in a cavity with surrounding destruction of the lung tissue. The second patch was found to be densely adherent to the lower two-thirds of the lower lobe of the left lung, and was so scarred down it was very difficult to resect. She did poorly post-operatively and ultimately the family withdrew care on postoperative day number fifteen, and the patient died within twenty-four hours. Hemoptysis was thought to be caused by bronchial collaterals due to her Ebstein's anomaly and left lung involvement by the retained left ventricular epicardial patches.

Discussion

There is one previously reported case of hemoptysis secondary to retained ICD patches following OHT, and two previously reported cases of an ICD patch eroding into the left lung. In the first case, a 57-year-old OHT patient presented with hemoptysis associated with an acute focal pneumonia. He underwent patch removal and lingulectomy. There was no infectious organism identified on final pathology.[11] The second case



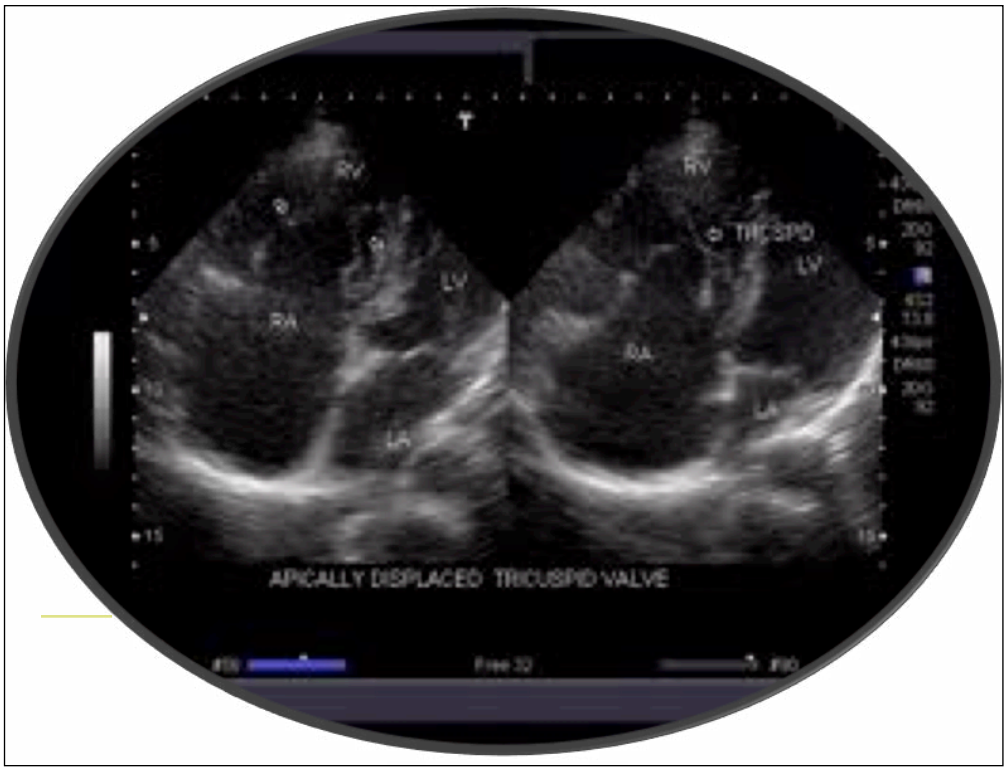


Image 3. Fluoroscopy 12-13-10 demonstrating bronchoalveolar collaterals

involved a patient with massive hemoptysis who died intraoperatively while attempting to remove the patch.[12] In the third case, a 42-year-old patient's ICD patch migrated through the RV, and had to be surgically removed on cardiopulmonary bypass.[13] In both cases, the migration was in the setting of an acute or chronic infection. There was no clear source of infection in our case, and the hemoptysis history extended over the course of 18 months. There are no previously reported similar cases in pediatric or adolescent literature to guide our care of complex congenital patients. Our patient ultimately succumbed to the complications related to epicardial ICD patch placement 16 years after its placement. It is a cautionary tale for our congenital cardiologists who continue to manage patients with very late ICD epicardial patch complications.

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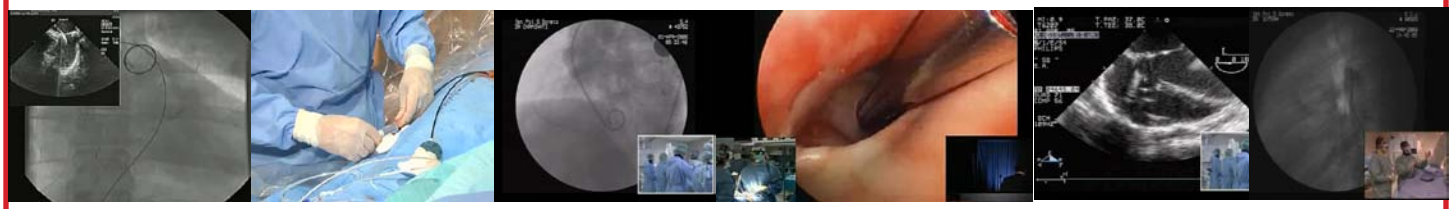

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Computerized Three-Dimensional Analysis of Chicken Cardiac Chambers During Diastole

By Tatiana A. Goodlett, MD; Igor V. Tverdokhleb, MD, PhD, Doctor of Science

Abstract

Innovations in embryo reconstruction not only facilitate medical education, they also serve as new tools for scientific studies of cardiogenesis and congenital heart diseases. During cardiogenesis, sizes of the heart's chambers change significantly, but few studies have attempted to quantify it. In our work we reconstructed and analyzed chicken hearts at stage HH 36 and HH 46 (Hamburger and Hamilton, 1951) during diastole. It was achieved by using three dimensional (3D) reconstruction software to align multiple histological sections of the embryonic heart into the stack of images to make a model. Obtained 3D computer models of the chicken embryo hearts during diastole were composed of the separate models of the main heart units (left ventricle cavity, right ventricle cavity, atrium cavity, myocardium of both ventricles).

In current work, 3D images are useful for further investigation of quantitative value of parameters through different stages of embryonic heart development in diastole. These approaches facilitate understanding of the architecture of the embryonic heart, and gives us the ability to estimate the quantitative amount of a wide spectrum of geometrical parameters of the chambers and the structure of the wall of the heart. They also serve as new tools for scientific investigation of cardiogenesis and Congenital Heart Disease.

Keywords

Heart, embryonic development, diastole, three-dimensional computer modeling

Conflict of Interest

The authors have declared that no conflict of interest exists.

Introduction

The chick embryo is one of the classical model systems for morphologic and physiologic study of the developing heart.[1,2]

Innovations in embryo reconstruction not only facilitate medical education, they also serve as new tools for scientific investigation of cardiogenesis and Congenital Heart Disease. During cardiogenesis, the sizes of chambers change significantly, but few studies have attempted to quantify them.

Studies by Keller et al. have attempted to quantify ventricular volumes at different stages of development and showed that these increase in size as the embryo grows, but how these volumes relate to those of the atria and outflow tract were not assessed.[3] Many details of cardiac morphogenesis are only now being uncovered, in part, because of the complexities of the developing geometries. The human heart becomes four-chambered by week 8, which is approximately the same time that the embryo can be visualized through ultrasound and, therefore, too late for detailed morphogenic study.[4,5]

Therefore, embryonic animal models and the 3D serial reconstruction using histological sections has radically improved understanding of heart development with the ability to combine geometry and the expressions of cell and/or matrix proteins.[6,7] While the exterior walls of the heart are generally smooth with large radii of curvature, the interior "lumens" of the heart, with varying trabecular, septal, and valvular geometries, are far more complex.

Results

Few studies to date have attempted to profile the changing geometry of the interior of the heart. Several studies have used different imaging modalities to explore developing hearts in 3D to identify morphogenic defects, [8,9; 10,11] but none of these studies focused on quantifying the 3D geometry of the different segments and chambers.

RV trabecular number usually decreased by HH36, but in this case trabecular spacing increased. Nonetheless, during morphogenesis, cardiac structures also present a differential growth that requires a quantitative approximation to analyze both their shape and size during cardiac growth. Pexieder et al. introduced quantitative approximation on human morphogenesis research; these studies found their clinical application with the ultrasound technique.[12] Tanner et al. conducted an exhaustive study on the quantitative human growth during the postnatal fetal period warranted some studies.[14,15]

However, during the embryonic period, these kinds of studies are very limited. Grant was the first to perform linear measurements in hearts of human embryos.[16] Mandarim-de-Lacerda et al. studied cardiac volume growth in fetuses and in human embryos, analyzing the data with the allometric method.[17,18] Blausen et al. determined embryonic cardiac volume in an attempt to obtain an estimate of the functional capability of the embryonic ventricle,[19] and finally, Wenink et al. created a quantitative approach to development of the atrioventricular valves. [20] The aim of this paper is to complement these studies with our data and 3D computer reconstruction.[20]

In the area of the developmental study of the heart, computer-assisted reconstruction and computer graphics (CG) have been used to visualize the developing heart of the mouse,[8, 10] chick,[21] and human.[22,23] In mice, three-dimensional sequential images of the developing heart have been made between E8.5 and E14.5.[24] Reconstructions of the heart at Stage 18 were earlier illustrated by Kramer and by Vernall. [25, 26]

Thus, the past few years we have seen the increasing popularity of the use of different methods of 3D reconstruction. One additional method that gives a good presentation of quantitative measurements of embryonic heart is a 3D computer modeling. The advantage of this method is the ability to reconstruct objects of that size, and at the same time provide accurate information about objects of investigation; hence, its wide use now in research work of different fields of embryogenesis.

This valuable information can be fully appreciated with work performed on a study of heart morphogenesis in diastole during early embryogenesis and interpreted only through an adequate method of 3D visualization.The aim of our research was to investigate quantitative value of parameters of chicken heart at stages (HH 36 and HH 46) during diastole.

Materials and Methods

Chicken embryos of Cobb 500 cross have served as a material for the research. Eggs were incubated at temperature 39,4˚C, relative humidity of 80%. The rotation of eggs was carried out with an interval of 8 hours. A stage of development was defined according to V. Hamburger, H. Hamilton (1951), taking into account recommendations of Martinsen.[27] Material was fixed in a Bouin's solution, dehydrated in graded ethanol, impregnated with chloroform, embedded in a paraplast. Serial sections (10 mkm) were focused in a horizontal plane. Sections were stained with haematoxylin of Geydengieden. Diastole was modeled with the help of KCl solution as it was previously described in the works by Mesud,[28] and Xiaowei.[29]

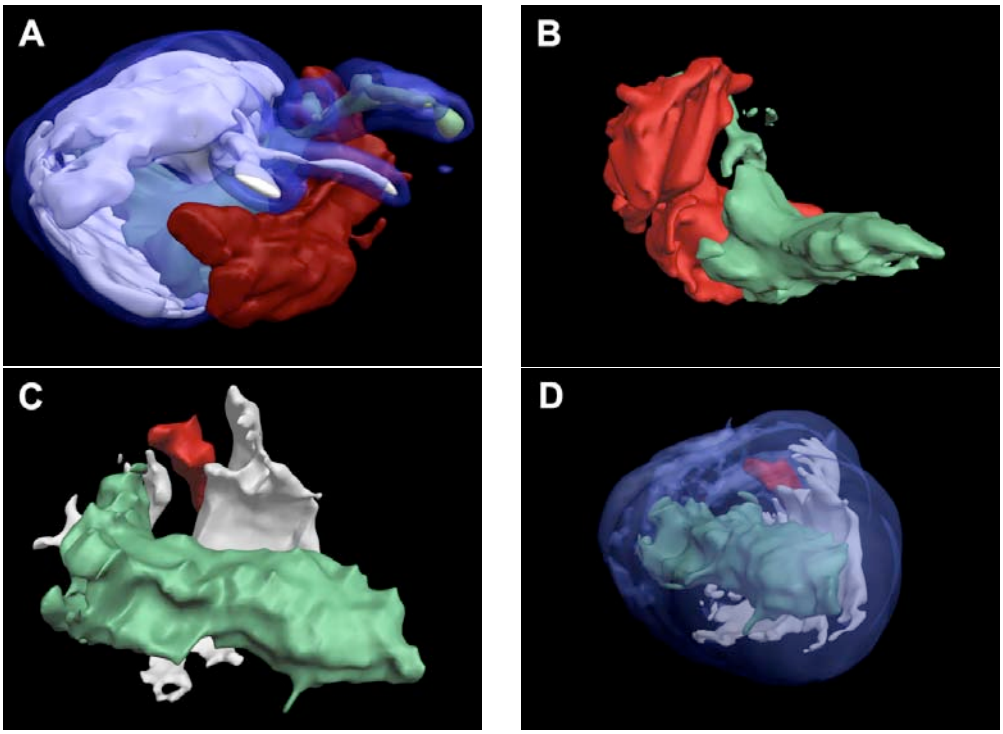

Figure 1 A, B: HH 36 and Figure1 C, D: HH 46. 3D reconstruction of chicken embryo's heart at HH stage 36, performed from the set of serial histological sections. A – Myocardial layer, surrounding RV and LV have been added (transparent blue color-50%), giving to the reader dimensional possibility to observe parameters in relation to the cavities. White color represents RV cavity, green – LV cavity, red – atrium.

For the creation of computer models we used Photoshop CS2 software (preparation of photos), Approximately 30-35 sections per heart were imaged. The images were then imported to AMIRA 5.0, and each image was rotated and/or translated in registration. The AMIRA software then generated the luminal heart volume using a cubic splice interpolation between each section (creation and alignment of contours), 3ds max 8.0 (definitive processing and visualization). Reconstruction was performed according to recommendations of Tverdokhleb.[30]

Animals. Animals were handled in accordance with the standards of Ukraine Dnipropetrovsk State Medical Academy (protocol № 7 from 27.04.2006) Conduction of Research with the Use of Experimental Animals protocol, and meets standards MOZ Ukraine № 231 from 01.11.2000. The research was conducted in accordance with the European Convention for the Protection of Vertebrate Animals Used for Experimental and Other Scientific Purposes (1986, ETS 123).[31]

Discussion

Embryonic cardiac morphogenesis is a complex 3D process that occurs rapidly. Several techniques have been and are routinely used to observe this developmental process, each with their own advantages and limitations. However, serial histological sections with a 3-dimensional computer model of the chicken embryo heart during diastole allows us to make a detailed analysis of heart during morfogenesis.

In our work, we analyze 3D models comprised (Figure 1. A, B: HH 36 and Figure 1. C, D: HH 46) of separate heart compartments: left ventricle (LV) cavity, right ventricle (RV) cavity, atrium cavity, and the myocardium of both ventricles. Quantitative characteristics of individual compartments of the chicken heart in diastole are shown in Table 1A for incubation Day 10 (HH stage 36) and Table 1B for incubation Day 21 (HH stage 46).

Analyzing the models (Table 1A, B), chicken heart stages (HH 36 and HH 46), we observed that the volume of LV stage (HH 46) cavity exceeds the volume of LV stage (HH 36) cavity by 524%, while the surface area of the LV stage (HH 46) cavity is 1218% larger then LV stage (HH 36) cavity. This explains why the ratio of surface to volume area in the left cavity stage (HH 36) smaller than in left cavity stage (HH 46) is 2.24.

Evaluating Table 1A and Table 1B, chicken heart stage (HH 36 and HH 46), it was revealed that the volume of RV cavity stage (HH 46) exceeds the volume of RV stage (HH 36) cavity by 378%, while the surface area of the RV stage (HH 46) cavity is 1599% larger than RV stage (HH 36) cavity, surface to volume area 4.23.

By visualizing the models, we can explain the prevalence of surface area over volume area of RV cavity stage (HH 46) to RV stage (HH 36) due to RV cavity height which increased by 251% and RV cavity width which increased by (213%). Since, the RV cavity stage (HH 46) acquires a coarse trabeculation pattern and tabecular spacing increased it effects the width and the height ratio, which is 0.85.

The volumetric analysis of the models allows explanation of the prevalence of surface area of LV stage (HH 46) to LV stage (HH 36) due to the irregular form of LV cavity and because of the prevalence of the LV cavity width (399%), while the height is (366%). The prevalence of surface-to-volume is due to the 1.09 times increase of the LV width.

In regard to myocardium, chicken heart stage (HH 36) and stage (HH 46), it was revealed that the volume of myocardium stage (HH 46) exceeds the volume of myocardium stage (HH 36) by 1549%, and the surface area of the myocardium stage (HH 46) is 1709% larger than myocardium stage (HH 36). This explains why the ratio of surface to volume area in the myocardium stage (HH 36) is smaller than in

Table 1A. Quantitative Characteristics of Individual Compartments of the Chicken Heart in Diastole, (HH Stage 36)

Name	Volume, $\times 10^9 \mu m^3$	Surface Area, $\times 107 \mu m^2$	Height, μm	Width, μm
LV cavity	3,88	2,81	1832	1472
RV cavity	3,49	2,90	2045	2578
Atrium cavity	2,81	3,21	1805	858
Myocardium	15,62	9,04	2969	3087

Table 1B. Quantitative Characteristics of Individual Compartments of the Chicken Heart in Diastole, (HH Stage 46)

Name	Volume, $\times 10^9 \mu m^3$	Surface Area, $\times 107 \mu m^2$	Height, μm	Width, μm
LV cavity	24,2	37,04	8536	7340
RV cavity	16,71	49,27	7184	8065
Atrium cavity	9,42	44,16	3759	2144
Myocardium	257,60	163,52	12273	10782

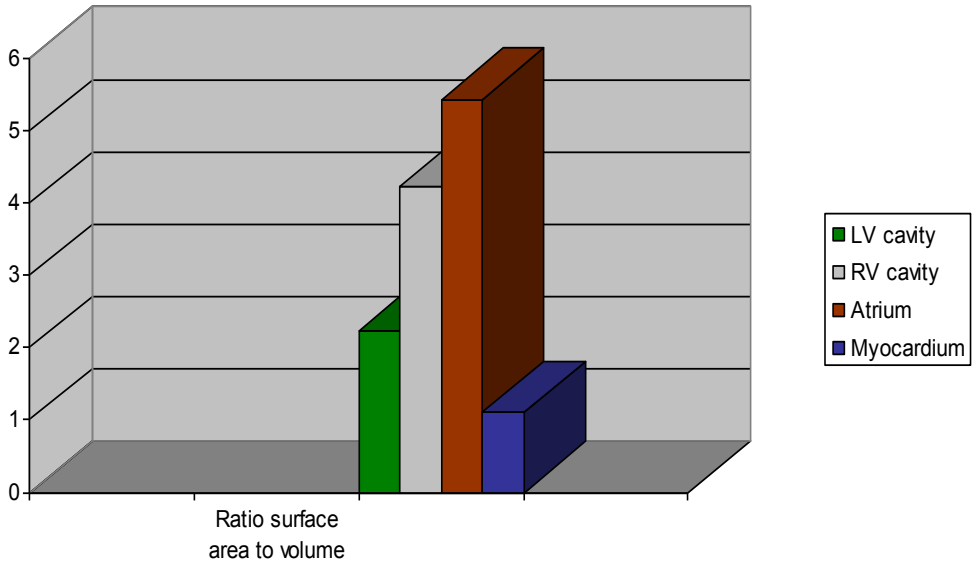

Figure E. Ratio of Surface area to Volume of different compartments at HH stage 46 to HH stage 36, show decrease of LV muscular mass, mostly due to trabecular loss and compensatory increase of the RV surface area, again predominantly in the trabecular component.

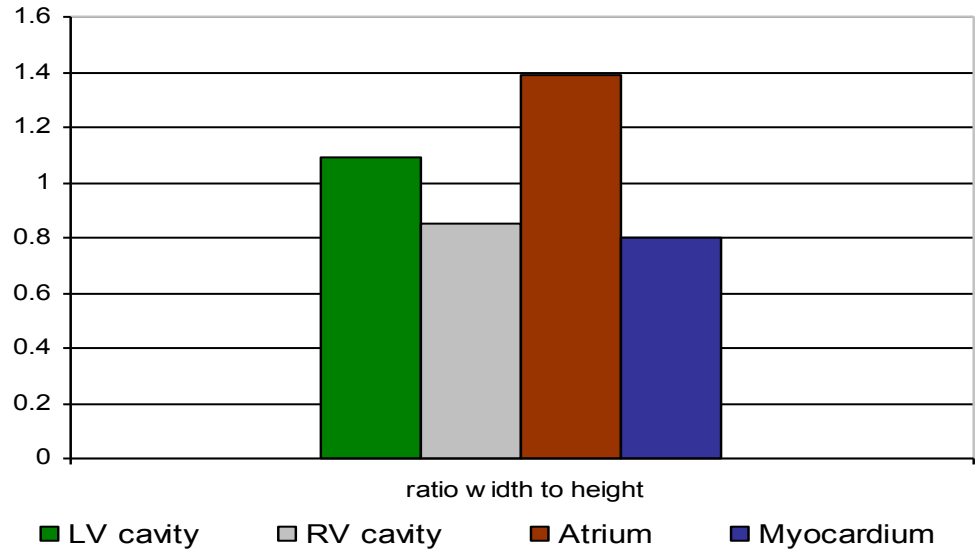

Figure F. Ratio of width to height of different compartments at HH stage 36 and HH stage 46 show that the RV cavity and myocardium are almost the same, mostly due to trabecular loss and compensatory increase of the RV surface area, again predominantly in the trabecular component.

myocardium stage (HH 46) (1.10), while the width to height is 0.80.

Interpreting the parameters of atriums at developmental stages (HH 36) and (HH 46) shows that the width and height atrium ratio (1.39) and the surface to volume ratio is (5.43) while the myocardium ratio (1.10). The artiums ratio of surface to volume compared to myocardium ratio exceeds five times, while the LV ratio (2.24) is almost twice smaller than the ratio of the RV cavity (4.23). Between stages (HH 36) and (HH 46) we have an almost equivalent ratio of height of RV (0.85) and height of myocardium (0.80).

Our data strongly suggest these approaches facilitate understanding of architecture of the embryonic heart, and gives us the ability to estimate the quantitative amount of a wide spectrum of geometrical parameters of chambers and structure of the wall of the heart. They also serve as new tools for scientific investigation of cardiogenesis and congenital heart disease; but such methods do not yet provide anything like resolution achieved by histology and are, therefore, of limited use for studies of morphological detail. Also, almost all of these studies and the new techniques are performed on larger objects of investigation, and cannot be applied for objects during embryogenesis to successfully show the accurate picture and performance of the heart and its usefulness for the design of strategies for early diagnosis of congenital heart disease.

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Case Report: Familial Supraventricular Tachyarrhythmia

By Sandra Williams-Phillips, MB.BS, DCH, DM Paediatrics (UWI)

Abstract

Supraventricular Tachycardia is the most common arrhythmia in childhood. The familial form is uncommon, especially in the Afro-Caribbean population. This index case is representing an Autosomal Dominant form from a paternal parent who was diagnosed as a teenager at the age of 19-years-old. The index case presented with the identical complaint, a decade younger at 9-years-of-age, indicating the need for chromosomal studies for further elucidation of definitive genetic component involved. As far as the author is aware, this is the first case of Familial Supraventricular Tachycardia in an Afro-Caribbean.

Keywords: Supraventricular tachyarrhythmia, re-entry, familial, chromosome, gene

Introduction

Supraventricular Tachycardia (SVT) is the most common dysrhythmia seen in children, with an incidence varying from 1:250 to 1:2500.[1- 5] It constitutes up to 40% of arrhythmias seen in childhood with a 30% occurrence in early infancy. Bondi (2011) classifies the dysrhythmias into three main groups based on etiological site of electrophysiological disturbance, which helps in differentiation by electrocardiographic or electrophysiological features. The first group is the reentrant accessory pathway tachycardia (AP), presumably using accessory Kent or James fibres. The second is the atrioventricular node reentry type of tachycardia (AVNRT), and the third due to ectopic tachycardia from the atria (AET).[1] The first group with the accessory Kent fibre, commonly has Wolf Parkinson White Syndrome with the classical short PR interval with delta wave on QRS complex.[1-5]

Clinical presentation of SVT is dependent on the age of the patient; in infants, symptoms usually occur in 30% to 40% by five months of age. These symptoms are non-specific including: lethargy, shortness of breath, poor feeding and irritability, and usually present with signs of Congestive Cardiac Failure (CCF). Cardiac Arrest and CCF usually occur if the tachydysrhythmia is sustained for more than 24 hours leading to an inability to maintain cardiac output. Many are misdiagnosed in this age group, especially when episodes are paroxysmal, which may be noticed by a caregiver and require a high index of suspicion.[1-9] A normal resting Electrocardiogram (ECG) and Echocardiogram does not rule out this diagnosis in an Infant, as it can occur in structurally normal hearts, and there may not be an occurrence of the dysrhythmia at the point in time when the ECG was taken. This applies to all age groups as occurred in this Index case. Unless the episodes occur daily, the Holter assessment and ECG may also be negative for a dysrhythmia, but may reveal an underlying Pre-excitation Syndrome or Ion Channelopathy.[1-9]

Older children who have the intellect to indicate that they are not well, usually present with more clearly and easily recognized symptoms before there is cardiac compromise, unless an Arrhythmogenic Cardiomyopathy occurs. Many in young childhood complain and call palpitations, chest pain. Palpitations are described as sticking, beating or beeping in chest, and classic symptoms of cardiac decompensation as lethargy, weakness, dizziness, syncope, seizure, poor exercise tolerance, and not being able to keep up with their peers, diaphoresis, heart racing. Presentation in later childhood and adolescent is clearer, as patients are able to explain symptoms as they occur, leading to earlier detection, and thus, less likely to lead to cardiac failure unless acute severe episodes occur especially when high rate of conduction of Supraventricular arrhythmia occurs leading to ventricular tachycardia and ventricular flutter with immediate cardiac arrest and or cardiac decompensation.[1- 9]

> ***"Supraventricular Tachycardia is the most common arrhythmia in childhood. The familial form is uncommon, especially in the Afro-Caribbean population."***

The importance of drug, dietary history, state of hydration and stress is important. The family history of Sudden Infant Death Syndrome, Sudden Death under 50 years, dysrhythmia, use of pacemaker and hereditary disorders such as Muscular Dystrophy and Marfan's Syndrome and Congenital Heart Disease and Deafness associated with Jervell Lange Nielson Syndrome, provide very important clues which will help to classify the type of disorder that can be associated with the child's arrhythmia.[5]

The index family includes a European father who is now 40 years-of-age, was diagnosed overseas at 19 years-of-age with an arrhythmia that still persists. The index case who is female of Caucasian European and Afro-Caribbean origin, presented with a tachyarrhythmia at 9 years-of-age.

Case Report

A highly intellect nine year-old pre-pubertal female, active in swimming and gymnastics, presented with palpitations two days and with a frequency in excess of ten times per day occurring at rest, on exertion and wakes patient at night during sleep. Duration of palpitation was for a few minutes, but it kept recurring. The palpitation was associated intermittently with dizziness, sticking praecordial chest pain and was exacerbated by exertion. There was no history of syncope, fainting or seizures. There were no relieving factors, and the palpitations resolved spontaneously during complete cessation of activity and lying or sitting. Vagal manoeuvers taught (ie. cold to face, Eyeball pressure, and one sided carotid sinus massage in neck) were not effective when used.

There was no history of deafness or hearing loss, no history of Congenital Heart Disease, Bronchial Asthma or wheezing. There was no significant factor in drug or dietary history, and no history of cardiac surgery. There was also no history of caffeine ingestion, energy drinks, high dose steroids or stimulants. There were no known allergies.

Multiple episodes of palpitations occurred despite compliance with beta-blockers with reduction to three days per week. Complete cessation occurred within two weeks of increasing dosage and administration of Flecainide on dosage of 5mg/kg in three divided dosages.

The father, a Caucasian European, now 40 years old, was diagnosed with Tachyarrhythmia from 19 years of age in Europe, and continues to have intermittent palpitations requiring attendance to hospital. He has never taken medication recommended, and was advised he had a structurally normal heart.

There is a family history of deafness in Maternal Aunt and Maternal Grandmother. There were two (2) separate incidences of Sudden Infant Death Syndrome on the maternal side of family. There was one instance of Sudden Death under 50 years of age on the maternal side. One maternal family member has deafness, which started at 20 years-of-age. A 14-year-old sister with the same parentage has Bronchial Asthma, but has no arrhythmia or congenital heart disease or deafness.

Exercise was restricted with no competitive sports and sustained exertion advised. Specifically, discontinue swimming and gymnastics normally pursued until advised.

On examination, there were no dysmorphic features in a pre-pubertal female:

- Weight: 28.2kg
- Height: 125cm
- Head Circumference: 54cm
- Normal Arm Span: Height ratio and upper lower body segment ratio. There was a negative wrist and thumb sign.
- Saturation (air): 99%.
- BP: 103 /70; no oedema; no clubbing.
- Resting Pulse was 82/min initially irregularly irregular intermittently with variable pulse volume which was non-collapsing.
- All peripheral pulses were palpable; there was no pulse deficit.
- Respiratory rate: 20/min.
- NYHA functional classification: 1[N], but becomes 11 to 111 during palpitations.
- Cardiovascular system examination after starting Atenolol 50mg showed the resting heart rate became regular with normal pulse volume and non-collapsing.
- Jugular venous pulse was not elevated. There were no thrills, precordial bulge, epigastric pulsation, palpable pulmonary component of the second heart sound and no Parasternal Heave.
- Apex beat was normal in the fifth left intercostal space in the mid-clavicular line. The first and second heart sounds were normal. The second heart sound was normally split and variable. There was no accentuation of the pulmonary component of the second heart sound.
- An ejection systolic murmur was noted in ULSB grade 1 of 6.
- There were no diastolic or continuous murmurs.
- Abdominal examination was normal with no hepatomegaly.
- The respiratory system was normal. There were no signs of muscular dystrophy or scoliosis, and no signs of congestive cardiac failure.
- Investigations showed: normal thyroid function, normal cardiac enzymes, normal C3, erythrocyte sedimentation rate, negative antinuclear antibodies, and mild elevation of anti-DNA of 6.6 (Normal 0.0 -6.0) of uncertain clinical significance.
- Urea and electrolytes, calcium, magnesium levels were normal.
- The resting Electrocardiogram (ECG) showed sinus rhythm with sinus arrhythmia. There was an inverted T in V2, which is a normal variant. No dysrhythmic episode occurred during the recording of the ECG, which was not to have upright T-wave interestingly whilst on Atenolol 50 mg, and then became inverted on Flecainide even when controlled for uncertain clinical significance.
- There was no specific ECG abnormality indicating underlying pre-excitation or Ion Channelopathy electrophysiological abnormality identified. There was no Wolf Parkinson White, Lown Ganong Levine, Mahaim, Long Q-T Syndrome, Brugada Syndrome or Epsilon wave.
- Holter report showed sinus rhythm with heart rates ranging from 51 to maximum of 214 beats per minute (bpm).
- 4537 SVT beats (4%) with 70 couplets and 388 Bigeminals; 166 runs totaling 2058 beats; 177 beats longest run in excess of 124 (bpm) and 3 fastest run at 214 bpm.
- There were five (5) Isolated Ventricular beats of no clinical significance.
- No maximum R-R interval was greater than 2 secs and the maximum noted was 1.74ms. Close scrutiny of the Holter ECG pattern showed an event of tachycardia, intermittent episodes of multiple P waves, and one of a short PR interval with no delta wave and normal duration QRS complex, suggestive of Lown Ganon Levine Syndrome. (Figure 1). These episodes were not noted during rest or at any other time on Holter assessment, and are not muscular in origin.
- Chest X-Ray had normal cardio-thoracic ratio and lung fields. There was a left aortic arch with normal ratio right and left bronchi with normal orientation of liver, spleen and stomach bubble making Isomerism unlikely.
- Echocardiogram showed a structurally normal heart. There were no signs of Ebsteins Anomaly, Uhl's Anomaly, Arrhythmogenic Right Ventricle, Corrected Transposition, Isomerism, Atrial Septal Aneurysm, Atrial Septal Defect, Superior or Inferior Sinus Venosus Defect, Mitral Valve Prolapse, Mitral Stenosis or Pulmonary Hypertension.
- Neither transoesophageal pacing, nor EP study or ablation is available in index country.
- Cardiac MRI: to rule out Arrhythmogenic right Ventricle/ Uhl's Anomaly is not available in Jamaica.

In summary, the Index case is a 9-year-old girl with Familial Supraventricular Tacharrhythmia confirmed on Holter assessment suggestive of Lown Ganong Levine Syndrome (Figure 1), controlled on Flecainide and an initial inadequate response to Atenolol who is an excellent candidate for EP study and ablation.

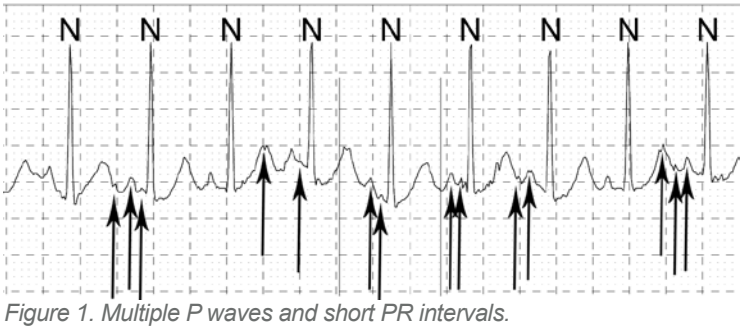

Figure 1. Multiple P waves and short PR intervals.

Discussion

The current literature is replete with documentation on Familial Tachyarrhythmia predominantly in Caucasians.[1-13] There have been studies on Spanish and Chinese families with Atrial Fibrillation with identification of a specific chromosome such as 10q22-24.[11-12] There is none, however, on an Afro-Caribbean population. Cases of Foetal Supraventricular Tachycardia have been documented.[13] The onsets of Cardiac Arrhythmias are determined by the gene involved and the interaction of the gene and the environmental factor which can be stimulants or repressors. The discovery of genetically-linked Ankyrins, which are responsible in cardiac electrical activity including, but apparently not restricted to the sodium, potassium, calcium and adenosine triphosphate activity. The Ankyrins were described first in Long Q-T Syndrome, but also contribute to the development of other types of arrhythmias such as the Brugada Syndrome. The existence of atrial arrhythmias indicates that abnormal ionic channels also exist in the atria. Further investigations would need to be pursued to see if Ankyrins are involved in the development and/or progression of Supraventricular Tachyarrhythmias.

There were no overt Pre-excitation syndromes such as: Wolf Parkinson White Syndrome or Lown Ganong Levine Syndrome seen on the surface resting ECG, but this can be concealed; hence, Digoxin was not used, as its use may increase conduction via the accessory pathway leading to increased conduction and potentially lethal ventricular arrhythmias.

The phenotypic presentation of the members, father and daughter, in the index family, supports an autosomal dominant gene with variable expression. But it has been documented that members of the same family have different types of arrhythmia. The history of Sudden Infant Death Syndrome, Sudden Death less than 50 years-of-age and deafness which is associated with Jervell Lange Nielson Syndrome on the maternal side of family, suggests the possibility of a hereditary dysrhythmia on the maternal side of the family.

Transoesophageal pacing, trans-catheter electrophysiological studies and ablation, minimally invasive epidural ablations and gene and/or chromosomal studies, which are diagnostic, therapeutic and curative modalities of investigation and treatment, are not available in the index country.[15,17,18,19]

The index family described has a Familial Tachyarrhythmia. Its phenotypic presentation suggests an autosomal dominant gene or chromosome with variable penetrance. The occurrence of SIDS and SD on the maternal side of the family suggests the possibility of an autosomal recessive gene being involved, and that further chromosomal and gene studies need to done in the index family.

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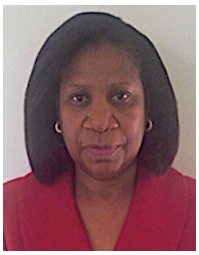

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iBook Review: The Illustrated Field Guide to Congenital Heart Disease and Repair, 3rd Edition

By Kiran K. Mallula, MD, MS; Ziyad M. Hijazi, MD, MPH

For those of you who have the *Illustrated Field Guide to Congenital Heart Disease and Repair, 3rd Edition*, the new iBook version for the Apple iPad is a stunning package of visual graphics with selective descriptions of the illustrations along with a brief overview of these depictions. The software copy is available for download from the Apple iBookstore and is priced less than the hard copy version. All of the chapters are presented electronically, as in the current hard copy version.

The iBook version of the 3rd Edition is published by Scientific Software Solutions, Inc. in Charlottesville, Virginia (www.pedHeart.com). The principle authors are: Allen Everett, MD and Scott Lim, MD. The illustrations are by Paul Burns who should be credited for the excellent visual appeal of the figures and line diagrams, including the echo and catheter-based still pictures. Contributing authors include: Marcia L. Buck, MD, Jane E. Crosson, MD, Howard P. Gutgesell, MD, Luca A. Vricella, MD, Stacie B. Peddy, MD, Marshall L. Jacobs, MD, David S. Cooper, MD and Jeffrey P. Jacobs, MD. The iBook version of this hard copy was developed by Cara Bailey.

The iBook version is a leap forward from the hard copy version of the *3rd Edition of the Illustrated Field Guide to Congenital Heart Disease and Repair.* There are ten chapters: The Normal and Fetal Heart, Congenital Heart Defects, Echocardiography, Catheterization Lab Interventions, Percutaneous Valve Insertion, Hybrid Therapies, Congenital Heart Surgeries, Cardiac ICU Topics, Introduction to Electrophysiology and Common Cardiac Pharmaceuticals.

The iBook can be viewed in the iPad horizontally in the current edition and comes with a host of user-friendly options. The pictures can be zoomed in completely to occupy the full screen. This feature can be a very useful tool for illustrating the various congenital heart disease lesions to patients in the outpatient clinic setting. It is versatile to use with a continuous scroll function of mini-icons of pages at the bottom of the screen, and one can zoom into a page with a simple tap. At this stage, the text cannot be zoomed once the page occupies the full screen, and this can be an area for further improvement in the future edition of the iBook.

The most useful aspect of this electronic version is the ability to jump from one section to another. There are cross-referenced words and figures throughout the text that take a reader from one aspect of a lesion to a different aspect of the lesion that is actually located on a different page.

The search feature is a very handy tool for querying any information throughout the book and it gives further links to Google and internet search options. Bookmarking is a very welcome feature. The text can be highlighted with different colors and underlined just like a paper book. An option for additional sticky notes throughout the book is also available. The copy and share feature is useful to share excerpts from the book with colleagues, patients and their families via Facebook, Twitter, message, and email platforms.

Further refinements that can be made in the future edition could include a 360 degree view format of the book. Echocardiography and cardiac catheterization movie clips can be a useful addition as this will further supplement user understanding of the subject. The index page numbers could have been linked to the text, but instead display as direct pages of the hard copy. Sharing of figures with a copyright statement will enhance the utility of the electronic version.

With more and more healthcare facilities utilizing the iPad and other tablets in the daily care of patients, this iBook fulfills several educational objectives. It is a perfect companion for daily use in teaching rounds for medical students, nurses, nurse practitioners, physician assistants and residents. It serves as a quick field guide for pediatric cardiology fellows during their training. It is an excellent reference for patients and families with its readability level for the non-physician. It also provides a quick practical update of the current clinical practices in the field of Pediatric Cardiology for the practicing physician involved in the care of patients with congenital heart disease. The iBook is a mesmerizing platform to convey more information in a pictorial fashion to our patients and their families.

In summary, this iBook is a clinically-oriented, graphically summarized treatise on Pediatric Cardiology. We would wholeheartedly recommend it to everyone who is involved in the care of congenital heart patients either directly or indirectly.

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The PICES Group: Highlights from the SCAI Conference, Orlando 2013

By Brent M. Gordon, MD

The Pediatric/Congenital Interventional Cardiology Early-Career Society (PICES) held a breakout session at the 2013 *SCAI* conference in Orlando. *PICES* was established in July 2011, and is currently a task force under the umbrella of the *Congenital Heart Disease Council of SCAI*. The group was created to support and advance the careers of young interventionalists in the fields of pediatric and adult congenital and structural heart disease.

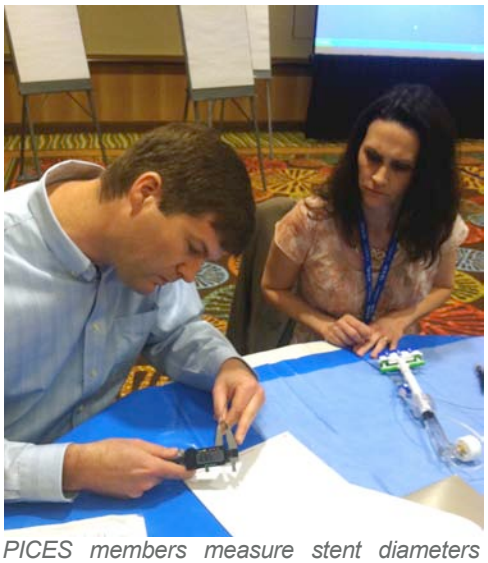
The goals of the *PICES* group include: promoting clinical education and multi-center research collaboration, improving transcatheter treatment of congenital heart disease in developing countries, and creating a professional network of young interventionalists and investigators. The newly-elected *PICES* executive board is composed of: President Brent M. Gordon, MD (Loma Linda University Children's Hospital); Research Chair Bryan H. Goldstein, MD (Cincinnati Children's Hospital); Clinical Chair Jeffrey W. Delaney, MD (Children's Hospital and Medical Center, Omaha); and Secretary Alex B. Golden, MD (Cleveland Clinic).

The *PICES* group is committed to improving the quality of care for congenital heart disease, and supporting research and innovation to this end. PICES currently has multicenter studies underway in the areas of stent testing and hybrid VSD (ventricular septal defect) closure. Twenty-three members of *PICES* met the morning before the congenital heart disease sessions began at *SCAI* to bench test many different types of stents utilized in the treatment of patients with congenital heart disease. Almost 40 stents including pre-mounted, coronary, larger diameter, and covered stents were evaluated for dilation potential and fracture properties. A manuscript will be forthcoming with the properties of each stent organized into a single repository so that all operators can keep this reference in their cardiac catheterization laboratories for quick and easy reference. This study, spearheaded by Matthew Crystal, MD (Morgan Stanley Children's Hospital-New York Presbyterian Hospital, Columbia University Medical Center), Saar Danon, MD, (Cardinal Glennon in St. Louis), and Brent Gordon, MD (Loma Linda University Children's Hospital), demonstrates the collaboration and teamwork that makes the *PICES* community unique. This partnership also includes international collaboration; for example, Gareth Morgan, MB, BCh (The Evelina Children's Hospital at Guys and St Thomas's, London) will be bench-testing stents currently utilized outside the United States and data from his investigation will be included with the final manuscript.

> ***"The PICES group currently has almost 100 members with representatives from the United States and around the world. PICES is very interested in establishing a greater membership outside of the United States to facilitate and foster international collaboration."***

The formal *PICES* breakout session at SCAI was attended by 25-30 members, and started with a welcome from outgoing president Daniel Gruenstein, MD. The *PICES* group has created a lecture series for early career interventionalists with previous talks dedicated to "Finding One's Career Niche," "How to Get an Idea Off the Ground," and "How to Conduct Multi-center Research Studies." Phil Moore, MD (University of California, San Francisco) and current SCAI CHD Council President was the keynote speaker at this year's breakout session with his talk entitled, "How to be a Great Catheterization Laboratory Director." Dr. Moore outlined various ways to build an outstanding catheterization program that focused on excellent clinical care, structured internal quality review, and the creation of strong relationships with referring physicians. He also touched on the importance of a team-based approach to treating our more complicated patients, and ways to improve buy-in from catheterization laboratory staff and hospital administration. The talk concluded with recommendations about the importance of having regular interactions with administrators to highlight successes and create an open line of communication during strategic program growth.

PICES was fortunate enough to have case presentations from Wendy Whiteside, MD (Mott Children's Hospital, Michigan) and Sarosh Batlivala, MD (The Children's Hospital of Philadelphia). Dr. Whiteside profiled two recent cases of ASD device erosion with an Amplazter septal occluder, while Dr. Batlivala



PICES members measure stent diameters during bench testing at the SCAI Conference in Orlando.

presented a challenging heterotaxy patient with unique physiology and significant portosystemic malformations. The cases generated lively discussion from the audience, and demonstrated numerous teaching points.

The *PICES* group currently has almost 100 members with representatives from the United States and around the world. *PICES* is very interested in establishing a greater membership outside of the United States to facilitate and foster international collaboration. There are no membership dues. *The PICES* email listserve is used for clinical discussion, planning projects, and as a forum for communication among its members and with the *PICES* Executive Board. The *PICES* website can be accessed from the *SCAI* homepage (www.scai.org) under the "About SCAI" section and "Committee" subsection. For further information, or to be added to the *PICES* list-serve please contact Alex Golden at alexgoldenmd@gmail.com.

The next formal *PICES* meeting will be in May 2014 at *SCAI* in Las Vegas.

CCT

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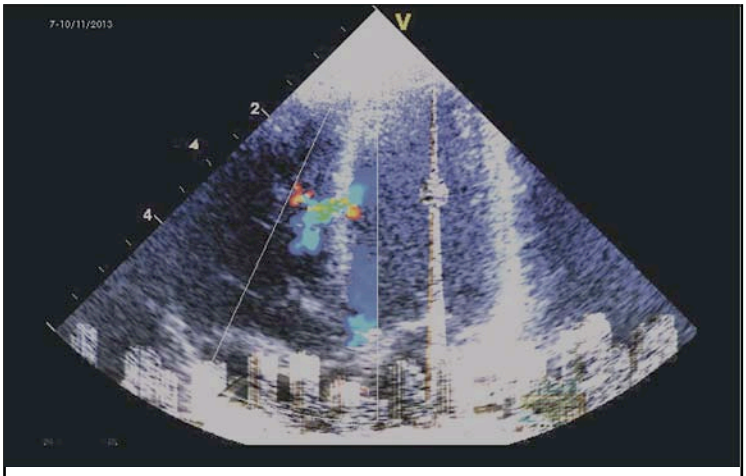

Basic Course on Congenital and Paediatric Echocardiography

November 7-8, 2013; Toronto Canada

- An introduction into the specific technical aspects of paediatric echocardiography
- Morphology demonstrations with echocardiographic correlations
- Overview of pre-operative and post-operative imaging of the most common congenital defects

3rd Annual Imaging Ventricular Function in Congenital and Acquired Heart Disease

November 9-10, 2013; Toronto Canada

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Medical News, Products and Information

New Technology Maps the Electronic Signals of the Heart Three-Dimensionally

Researchers at the Intermountain Heart Institute at Intermountain Medical Center have developed a new 3-D technology that for the first time allows cardiologists the ability to see the precise source of atrial fibrillation in the heart - a breakthrough for a condition that affects nearly three million Americans.

This new technology that maps the electronic signals of the heart three- dimensionally significantly improves the chances of successfully eliminating the heart rhythm disorder with a catheter ablation procedure, according to a new study presented at the May 2013 *Heart Rhythm Society's National Scientific Sessions* in Denver.

Atrial fibrillation occurs when electronic signals misfire in the heart, causing an irregular, and often chaotic, heartbeat in the upper left atrium of the heart.

Symptoms of atrial fibrillation include irregular or rapid heartbeat, palpitations, lightheadedness, extreme fatigue, shortness of breath or chest pain. However, not all people with atrial fibrillation experience symptoms.

"Historically, more advanced forms of atrial fibrillation were treated by arbitrarily creating scar tissue in the upper chambers of the heart in hopes of channeling these chaotic electrical signals that were causing atrial fibrillation," said researcher John Day, MD, Director of the Heart Rhythm Specialists at the Intermountain Heart Institute at Intermountain Medical Center. "The beauty of this new technology is that it allows us for the first time to actually see three-dimensionally the source of these chaotic electrical signals in the heart causing atrial fibrillation."

Previously, cardiologists were able to map the heart in 3-D to enhance navigation of catheters, but this is the first time that they've utilized 3-D imaging technology to map the heart's specific electronic signals. Armed with this information, cardiologists can now pinpoint exactly where the misfiring signals are coming from and then "zap" or ablate that specific area in the heart and dramatically improve success rates.

With this new technology, cardiologists will now be able to treat thousands more patients who suffer from advanced forms of atrial fibrillation and were previously not felt to be good candidates for this procedure.

"The capabilities of the new technology can be compared to a symphony concert," said Jared Bunch, MD, Medical Director for Electrophysiology Research at the Intermountain Heart Institute at Intermountain Medical Center. "During the concert, you have many different instruments all playing different parts, much like the heart has many frequencies that drive the heartbeat. This novel technology allows us to pinpoint the melody of an individual instrument, display it on a 3-D map and direct the ablation process."

The research team used the new 3-D mapping technology on 49 patients between 2012 and 2013 and compared them with nearly 200 patients with similar conditions who received conventional treatment during that same time period.

About one year after catheter ablation, nearly 79% of patients who had the 3-D procedure were free of their atrial fibrillation, compared to only 47.4% of patients who underwent a standard ablation procedure alone without the 3-D method.

"This new technology allows us to find the needles in the haystack, and as we ablate these areas we typically see termination or slowing of atrial fibrillation in our patients," says Dr. Day.

All of the patients in the study had failed medications and 37% had received prior catheter ablations. The average age of study participants was 65.5 years old and 94% had persistent/chronic atrial fibrillation.

Previous research has shown that the incidence of atrial fibrillation increases with age. A report from the American Heart Association shows the median age for patients with atrial fibrillation is 66.8 years for men and 74.6 years for women.

If untreated, atrial fibrillation can lead to blood clots, stroke and heart failure. In fact, people with atrial fibrillation are five times more likely to have a stroke than people without the condition.

Mutation Causing Wrong-Way Plumbing Explains One Type of Blue Baby Syndrome

Total Anomalous Pulmonary Venous Connection (TAPVC), one type of "Blue Baby" Syndrome, is a potentially deadly congenital disorder that occurs when pulmonary veins don't connect normally to the left atrium of the heart. This results in poorly oxygenated blood throughout the body, and TAPVC babies are born cyanotic - blue-colored - from lack of oxygen.

TAPVC is usually detected in newborns when babies are blue despite breathing normally. Life-threatening forms of the disorder are rare – about 1 in 15,000 live births. A closely related, but milder disorder, Partial Anomalous Pulmonary Venous Connection (PAPVC), in which only some of the pulmonary veins go awry, is found in as many as 1 in 150 individuals.

Now, researchers have found that a mutation in a key molecule active during embryonic development makes the plumbing between the immature heart and lungs short-circuit, disrupting the delivery of oxygenated blood to the brain and other organs. The mutation ultimately causes blood to flow in circles from the lungs to the heart's right side and back to the lungs.

Senior author Jonathan A. Epstein, MD, Chair of the Department of Cell and Developmental Biology, at the Perelman School of Medicine, University of Pennsylvania, and colleagues from The Children's Hospital of Philadelphia, describe in *Nature Medicine*, that a molecule called Semaphorin 3d (Sema3d) guides the development of endothelial cells and is crucial for normal development of pulmonary veins. It is mutations in Sema3d that cause embryonic blood vessels to hook up in the wrong way.

Epstein is also the William Wikoff Smith, Professor and Scientific Director of the Penn Cardiovascular Institute. Karl Degenhardt, MD, PhD, Assistant Professor at The Children's Hospital of Philadelphia; Manvendra K. Singh, PhD, an instructor of Cell and Developmental Biology at Penn; and Haig Aghajanian, a graduate student in Cell and Molecular Biology at Penn are the co-first authors on the paper.

Physicians thought that TAPVC occurred when the precursor cells of the pulmonary vein failed to form at the proper location on the embryonic heart atrium. However, analysis of Sema3d mutant embryos showed that TAPVC occurs despite normal formation of embryonic precursor veins.

In these embryos, the maturing pulmonary venous plexus, a tangle of vessels, does not connect just with properly formed precursor veins. In the absence of the Sema3d guiding signal, endothelial tubes form in a region that is not normally full of vessels, resulting in aberrant connections. Normally, Sema3d provides a repulsive cue to endothelial cells in this area, establishing a boundary.

Sequencing of Sema3d in individuals affected with anomalous pulmonary veins identified a point mutation that adversely affects Sema3d function in humans. The mutation causes Sema3d to lose its normal ability to repel certain types of cells to be able to guide other cells to grow in the correct place. When Sema3d can't keep developing veins in their proper space, the plumbing goes haywire.

Since it's already known that semaphorins guide blood vessels and axons to grow properly, the authors surmise that Sema3d could be used for anti-angiogenesis therapies for cancer, to treat diabetic retinopathy, or to help to grow new blood vessels to repair damaged hearts or other organs.

Daniele Massera, Qiaohong Wang, Jun Li, Li Li, Connie Choi, Amanda D. Yzaguirre, Lauren J. Francey, Emily Gallant, Ian D. Krantz, and Peter J. Gruber are co-authors.

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Digisonics Showcases Enterprise PACS and Structured Reporting Solutions at SIIM 2013

Digisonics exhibited its Enterprise PACS and Structured Reporting Solutions for cardiology, OB/GYN, radiology and general ultrasound studies at this year's Society for Imaging Informatics in Medicine (SIIM) Annual Meeting.

The Digisonics system is a vendor-neutral, enterprise-wide image management and structured reporting system with a configurable clinical database, extensive structured reporting tools, and a high-powered PACS for ultimate reliability and workflow efficiency. Digisonics is the only solution that enables users to quickly review and generate structured reports for cardiology, OB/GYN, radiology and general ultrasound studies. Utilizing the single Digisonics structured reporting solution across all departments reduces enterprise efforts to manage and support multiple disparate systems.

Digisonics solutions support a vendor-neutral approach for interfacing with the wide-range of disparate systems spanning many different areas within the IT and clinical domain. Standard and proprietary data elements can be transmitted and received via a selection of industry proven interfacing protocols. Examples include patient demographic and measurement import from ultrasound machines, data import and export of ADT, ORM, ORU and billing messages from IT systems via HL7, and DICOM image import/export.

Digisonics Enterprise Structured Reporting Solutions also interface directly with voice recognition software. Users can review images and preliminary reports in PACS, then dictate the summary via their voice recognition software. The summary is then sent to the Digisonics structured reporting system via HL7 for dissemination. The end result is a seamless digital workflow with improved efficiency, accuracy and turnaround times.

For further information, visit: www.digisonics.com

Letters to the Editor

Congenital Cardiology Today welcomes and encourages Letters to the Editor. If you have comments or topics you would like to address, please send an email to: LTE@CCT.bz, and let us know if you would like your comment published or not.

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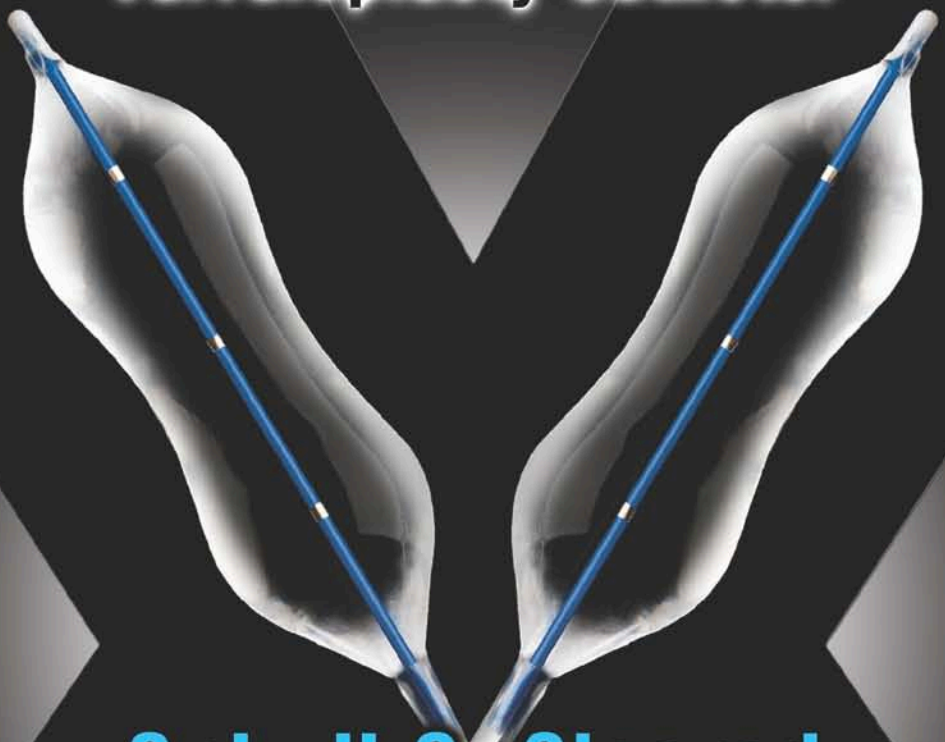

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