Contributions Dedicated to Global Education and Training on Fetal Echocardiography

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Background

- In 1994, about 131 millions babies were born worldwide, approximately 7.3 millons birth defect cases occur in about 5.6 percent of the newborns.
- The most common was congenital heart disease, which occurs in about eight out of one thousand newborns. The total number was up to 1.05 millions babies with congenital heart disease per year worldwide.
- Fetal echocardiography had not been well explored due to limited knowledge and experience, equipment quality and limitations, and limited scanning time per patient.

Introduction

- CHOP has offered fetal cardiac imaging services since 1987, making it one of the earliest centers in the USA.
- With the great leadership and teamwork, FHP at CHOP became one of the best centers in the world. Provided comprehensive fetal cardiovascular imaging for diagnosis, consultation, treatment, delivery planning and newborn management.
- Fetal medicine created urgent needs for our continued growth. We also strove to share knowledge and experience for the medical professionals over the world.

Since 1994 … …

Over 30 years of commitment for global education and training

What did we do?

- Extensive lectures and workshops, Live scan demonstrations

- Onsite hospital visits, Grand Rounds, hands-on teaching

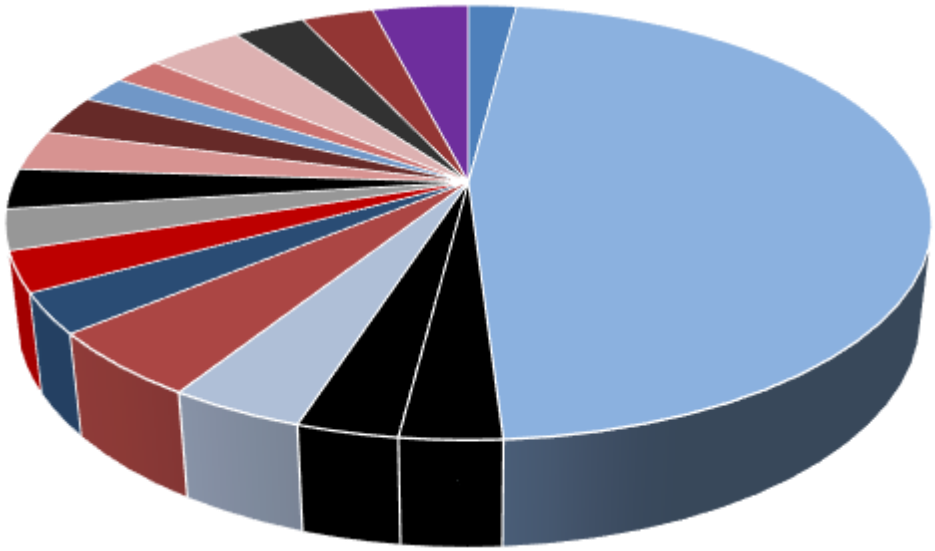
- International Collaboration in clinic and research, Commitment to Knowledge Sharing

- Facilitating advanced training at CHOP, Hosting nearly 100 visiting physicians from around the world

Teaching someone how to fish is more important than giving them a fish

Our Global Visiting Scholars

Visiting scholars from 18 countries



- Austria
- china
- Denmark
- Finland
- Italy
- Japan
- Netherlands
- Norway
- Poland
- Spain
- Australia
- Sweden
- Switzerland
- Taiwan
- United Kingdom
- Ukraine
- Thailand
- Mexico

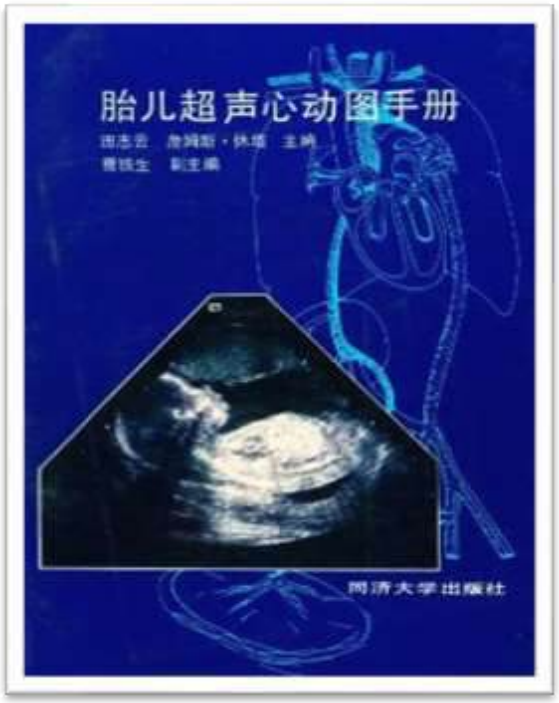
What we see in China

Large number of patients, hospitals overcrowded,
Physician’s workflow overloaded

Honored to be many "First" in China

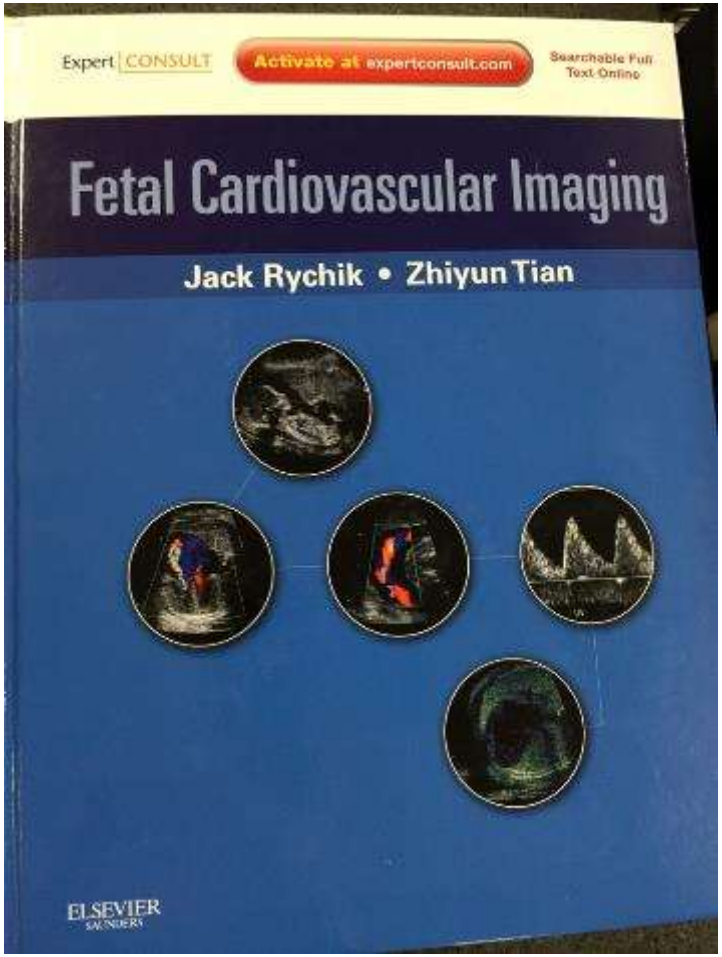
- The first foreign scholars to promote fetal echocardiography in China
- The first textbook of fetal echocardiography
- The first fetal echo conference, real-time scan
- Spread "Fetus as A Patient" medical ethics to China
- China-US cooperate to establish the first fetal echo training center
- The first American experts to be visiting professors for the fetal cardiology.

The First Textbook of Fetal Echocardiography in CHINA 1994



- First Fetal Echocardiography textbook in China
- Many Chinese Ultrasound Physicians use this as primary guide to enter fetal cardiac imaging
- Reference resource and learning tool for fetal heart disease in China

The New Textbook of Fetal Cardiovascular Imaging



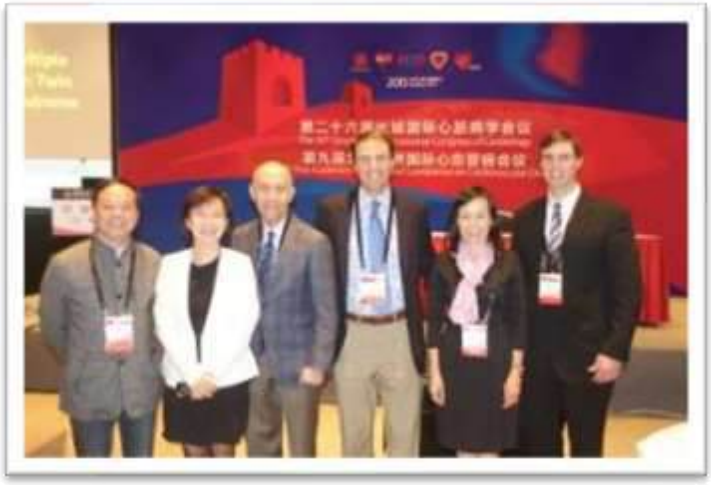
- New “Fetal Cardiovascular Imaging” textbook published in 2010.
- Has been translated to Chinese in 2012.
- Second edition will be published in 2025.

Fetus as a Patient

- Redefine the new concept of fetal ultrasound diagnosis, emphasizing the fetus as the patient, he / she is not a subsidiary of the mother
- Comprehensive prenatal care is important for both mother and fetus. Many heart diseases can be treated with good results.

Lectures in China

Lectures in China



Lecture tour in China-sample of one trip

10 Day trip: (Rychik-Blue, Tian-Red)

Day 1, People Hospital of Ordos, Ordos, Inner Mongolia

The fetuses with heart disease- diagnosis and management before and after birth

Hospital visit

Day2, 3, Qingdao City , Regional conference

Frontiers in Fetal Cardiology-diagnosis, management and treatment

Fetus with Single ventricle-diagnosis and management

Fetal Complex CHD, key point of the images

Fetus with CHD-Cases show and discuss

Day 4 and 5, Beijing, Great Wall international Cardiology Conference

Review and outlook on hot topics of fetal heart disease in US

Fetal Congenital Heart Disease: Postnatal Management and Surgery

Treating the Fetus with Heart Disease before Birth: New Strategies to Improve Outcome

Fetal Arrhythmias: Fast and Slow, Diagnosis and Treatment

Day 6 and 7, Nanjing, National Fetal Echo conference

The hot topics in fetal Cardiology

The fetus with Single ventricle-diagnosis and management

Prenatal diagnosis of anomalous pulmonary venous drainage

Prenatal diagnosis of aortic arch anomalies

Lecture tour in China-sample of one trip

Day 7 and 8, Zhejiang Children's Hospital, Hangzhou

Hypoplastic Left Heart Syndrome – Hyperoxygenation, Doppler Assessment and Intervention for Restrictive Atrial Septum

Hands on and demonstration

Hospital visit

Day 9, Wuhan

Hypoplastic Left Heart Syndrome – Hyperoxygenation, Doppler Assessment and Intervention for Restrictive Atrial Septum

New advances in Fetal Cardiovascular Imaging

Prenatal diagnosis of anomalous pulmonary venous drainage

Prenatal diagnosis of aortic arch anomalies

Day 10, Foshan

Frontiers in Fetal Cardiology-diagnosis, management and treatment

The cardiovascular manifestations of the Twin-Twin transfusion syndrome

Fetal arrhythmias-Key to diagnosis, Fast and slow

Grand rounds and skill Training

Facilitating advanced training at CHOP

- The first center to provide fetal echocardiography training for global visiting physicians.
- The training center also demonstrated standards and excellence for fetal cardiac service.
- More than 500 physicians visited FHP at CHOP for 1-5 days.
- 42 Chinese physicians have received 3-6 months formal training. Those returning to China have become the leaders of the Chinese Fetal Cardiac Center.

Training in CHOP

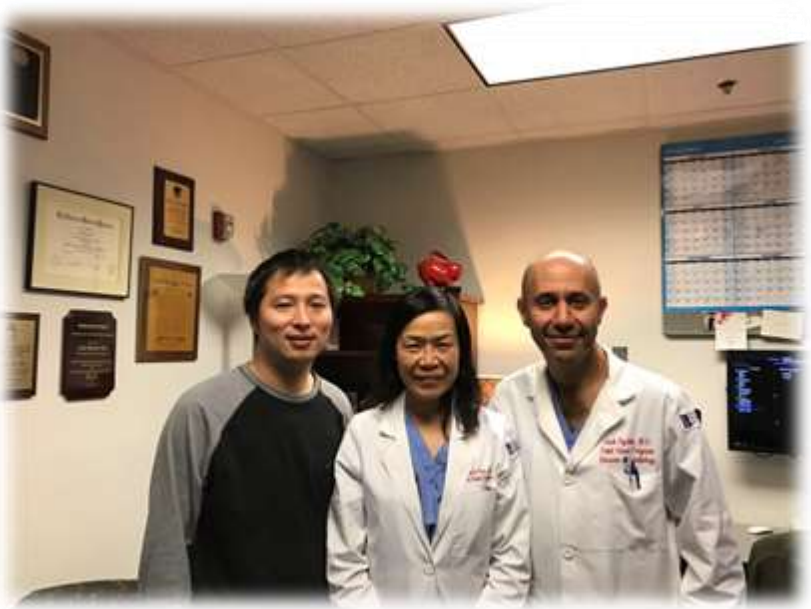
Fuzhou Dongfang Hospital

Tianjin Obs & Gyn Hospital

Nanjing Maternal &Child Health Hospital

Xian Tangdu Hospital

Training in CHOP



Hubei Maternal & Children's Healthcare Hospital

Training in CHOP

Xiangya 2nd Hospital of Central South University

Suzhou Municipal Central Hospital

Beijing Obstetric & Gynecology Hospital

Training in CHOP

Beijing Anzhen Hospital

Reunion

The Achievements of the Trainees who returned to Hospitals in China

Nanjing Maternal and Child Health Hospital

2016

2024

Nanjing Maternal and Child Health Hospital

- Returned to the hospital in 2006, all patient examinations in the past 18 years have followed CHOP Standard procedure. Quality of service maintained and all data from scans recorded and stored for future research
- In 2024, completed a total of 5600 comprehensive fetal Echo cases, 550 CHD cases were detected.

Hubei Province Maternal and Child Health Hospital

2016

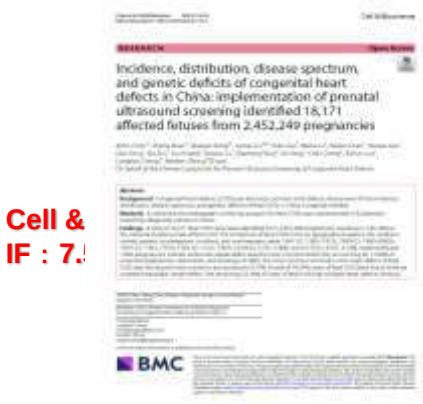
2025

Hubei Province Maternal and Child Health Hospital

- In cooperation with CHOP since 2006, it has become a prenatal diagnosis training base for the Ministry of Health.
- There are 88 doctors, a total of 65 ultrasound examination rooms, and 70 ultrasound machines.
- Leads a CHD incidence and distribution survey. 92 hospitals participated. A total 1,436,270 fetuses were included.
- Regional fetal diagnosis referral and consultation center. It receives more than 10,000 fetal heart referrals annually, with CHD detection rate 9.5%.

Hubei Province Maternal and Child Health Hospital (Published articles in the past 3 years)

Journal of Translational Medicine
IF： 8.440



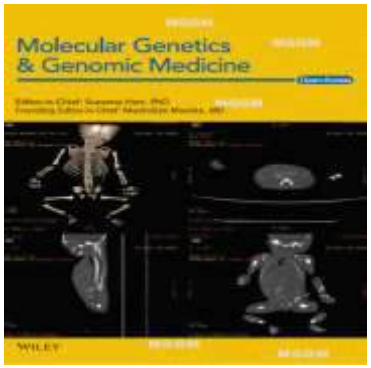
Cell & Bioscience
IF： 7.5

npj Genomic Medicine
IF： 6.083

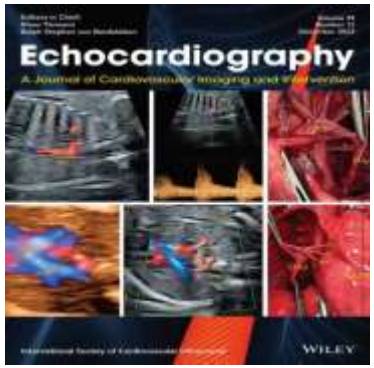
BMC Medical Genomics
IF： 3.622

BMC Medical Genomics
IF： 3.622

Clin Genet
IF： 3.578



Cover article
IF： 2.183



Cover article
IF： 1.874

Beijing Anzhen Hospital Ultrasound Department-II

2016

2024

Beijing Anzhen Hospital Ultrasound Department-II

- With the support of CHOP, the first Maternal - Fetal Medicine Consultation and Management Center for Fetal Heart Disease in China was established in 2013.
- Promote integrated maternal - fetal medicine management nationwide, including 11 prenatal diagnosis units in 8 provinces and 52 prenatal screening units.
- Collecting well designed maternal and fetal information and developing large number of fetal database cases-25,000 cases, since 2008
- Became a national fetal heart diagnosis and consultation center. Complex heart disease cases are 15%, due to large number of referral.

International academic exchange

With the support of professor Rychik and Professor Tian the first Maternal - Fetal Medicine Consultation Center for Fetal Heart Diseases in China was established in 2013

scholars under joint exchange

Yihua He

Jiancheng Han

Zhongshan Gou

Xiaowei Liu

Beijing Anzhen Hospital Ultrasound Department-II Maternal - Fetal Medicine Consultation Center

Beijing Anzhen Hospital Ultrasound Department-II (Representative Publications in 2024)

SCI 22 papers (Total IF 190.36)
Q1：10 papers　IF＞6：13 papers

	Authors	Tile	Journal	IF
1	Han J（Co-first author）,He Y（Co-Corresponding author）	Paternal Preconception Hepatitis B Virus Infection and Risk of Congenital Heart Disease in Offspring	JAMA Pediatrics	24.7
2	Xu Z（Co-first author）	B-type natriuretic peptide levels predict long-term mortality in a large cohort of adults with congenital heart disease	European Heart Journal	39.3
3	Liu R（Co-first author）	Mononucleotide Ameliorates Lipid_x0002_Induced Cardiomyopathy by Repressing the CD36–TLR4 Axis	Circulation Research	20.1
4	Xu Z（Co-first author），He Y（Co-Corresponding author）	Viscosity Corrected Pulmonary Resistance Index in Paediatric Pulmonary Arterial Hypertension	Am J Respir Crit Care Med	19.3
5	Ruan Y（Co-first author），He Y（Co-Corresponding author）	Maternal Exposure to Extreme Cold Events and Risk of Congenital Heart Defects: A Large Multicenter Study in China	ENVIRONMENTAL SCIENCE & TECHNOLOGY	11.4
6	Ruan Y（Co-first author），He Y（Co-Corresponding author）	Interaction between ozone and paternal smoking on fetal congenital heart defects among pregnant women at high risk: a multicenter maternal-fetal medicine study.	World Journal of Pediatrics	8.7
7	Zhou J（Corresponding author）	SILARGrowthofZnONSs/CdSQDsontheOpticalFiber-BasedOptoElectrodewithGuidedInSituLightandIts Applicationforthe “Signal-On” DetectionofInfammatoryCytokine	Analytical Chemistry	7.4

Beijing Anzhen Hospital Ultrasound Department-II (Representative Publications in 2024)

	Authors	Title	Journal	IF
8	Ruan Y（Co-first author），He Y（Co-Corresponding author）	Maternal exposure to ambient ozone and fetal conotruncal heart defects in China: A multicenter cohort study	Ecotoxicology and environmental safety	6.8
9	Han J（Co-Corresponding author）	Multi-modality imaging of the tuberculous granuloma in the right atrium	European Heart Journal-Cardiovascular Imaging	6.7
10	Song L，Han J（Co-Corresponding author） He Y（Co-Corresponding author）	Isolated lipoleiomyomas in the right ventricle	European Heart Journal-Cardiovascular Imaging	6.7
11	Deng H, He Y	Multimodality Imaging in Accurate Diagnosis of a Rare Case of Coronary Arteriovenous Fistula	Circ Cardiovasc Imaging	6.5
12	Zhou J（Co-Corresponding author）	Design and analysis of self-priming extension DNA hairpin probe for miRNA detection based on a unified dynamic programming framework	Analytica Chimica Acta	6.06
13	Yang X，He Y	A UFO-like cavernous haemangiomas in the atrial septum visualized by three-dimensional transoesophageal echocardiography	European Heart Journal-Cardiovascular Imaging	6.3
Accepted International Conference Abstract			**23**	

Collaboration in Research with Hospitals in China

Cooperation with Tianjin

Central Obstetrics & Gynecology Hospital

Collaboration in Publications

- Participated in Chinese research, in literature monograph writing and publishing.

Collaboration in Publications

A vision for an International Society for Fetal and Perinatal Cardiovascular Disease

Jeffrey Phillip Jacobs[a], Jack Rychik[b], Gerald Tulzer[c], Jean-Claude Fouron[d], Dev Maulik[e], Wayne Tworetzky[f], Bohdan Maruszewski[g], Ganesh Acharya[h] and James C. Huhta[i]

Purpose of review
The purpose of this review is to explain why it is now time to create an International Society for Fetal and Perinatal Cardiovascular Disease.
Recent findings
Rapid advances in four domains that involve the professionals caring for patients with congenital cardiac disease all point to the fact that it is now time to create an International Society for Fetal and Perinatal Cardiovascular Disease: fetal diagnosis – the improved ability to diagnose prenatal cardiovascular disease due to education and improved ultrasound technology; subspecialization – the development of perinatal cardiology as a true subspecialty of the professions of pediatric cardiology and perinatology; analysis of outcomes – the multidisciplinary international efforts in the areas of nomenclature and databases for the analysis of outcomes of treatments for patients with congenitally malformed hearts, efforts that span traditional geographic and subspecialty boundaries; globalization – the rapidly evolving global organization of professionals caring for patients with congenital heart disease.
Summary
Healthcare professionals caring for the pregnant woman and fetus with congenital cardiac disease would be enthusiastic about the creation of an International Society for Fetal and Perinatal Cardiovascular Disease in order to achieve multiple objectives: to discuss the management of prenatal and perinatal cardiovascular disease (not exclusively cardiac malformations); to benefit from educational programs covering prenatal and perinatal physiology and pathophysiology, clinical and technical topics, as well as genetic, ethical, and psychosocial aspects of this relatively new discipline; and finally to share our basic science, translational, and clinical research interests.

Keywords
congenital heart disease (CHD), database, fetal cardiology, fetal echocardiography, globalization, nomenclature, perinatal cardiology, ventricular ultrasound, professional responsibility

Current Opinion in Pediatrics 2008, 20:532–537

Pediatric Cardiology
https://doi.org/10.1007/s00246-018-1966-9

ORIGINAL ARTICLE

Surveillance Testing and Preventive Care After Fontan Operation: A Multi-Institutional Survey

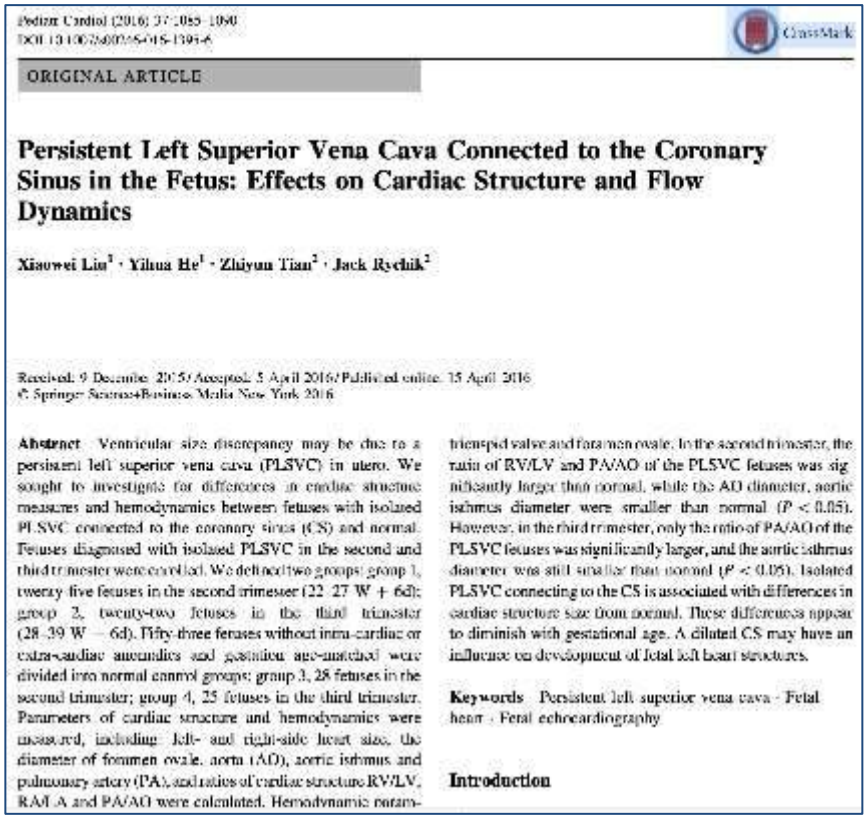
Michael V. Di Maria[1] · David W. Brown[2,3] · Frank Cetta[4] · Salil Ginde[5] · David Goldberg[6] · Shaji C. Menon[7] · Heather M. Phelps[8] · Jack Rychik[9] · Kurt R. Schumacher[9] · Philip Thrush[10] · Gruschen Veldtman[11] · Gail Wright[12] · Adel K. Younoszai[1]

Received: 9 March 2018 / Accepted: 16 August 2018

Abstract
More children with single ventricle heart disease are surviving after Fontan surgery. This circulation has pervasive effects on multiple organ systems and has unique modes of failure. Many centers have created multidisciplinary programs to care for these patients. Our aim was to survey such programs to better understand current approaches to care. We hypothesized that significant variability in surveillance testing strategy would be present. Eleven academic institutions with established Fontan care programs performing a combined estimated 300 Fontan surgeries per year, with a total population of 1500–2000 Fontan patients, were surveyed using a REDCap survey regarding surveillance testing and basic practice philosophies. Fontan care programs were structured both as consultative services (64%) and as the primary clinical team (9%). Electrocardiograms (73%) and echocardiograms (64%) were most commonly obtained annually. Serum studies, including complete blood count (73%), complete metabolic panel (73%), and Brain-type natriuretic peptide (54%), were most commonly obtained annually. Hepatic testing consisted of liver ultrasound in most centers, obtained biennially (45%) or > every 2 years (45%). Liver biopsy was not routinely recommended (54%). Neurodevelopmental outcomes were assessed at most institutions (54%), with a median frequency of every 3–4 years. There is considerable variability in the surveillance testing regimen and management strategy after a Fontan procedure at surveyed programs. There is an urgent need for surveillance guidelines to reduce variability, define quality metrics, streamline collaborative practice, and prospective research to better understand the complex adaptations of the body to Fontan physiology.

Keywords Fontan · Surveillance testing · Multidisciplinary clinic

Collaboration in Publications



Pediatr Cardiol (2016) 37:1085–1090
DOI 10.1007/s00246-016-1393-6

ORIGINAL ARTICLE

Persistent Left Superior Vena Cava Connected to the Coronary Sinus in the Fetus: Effects on Cardiac Structure and Flow Dynamics

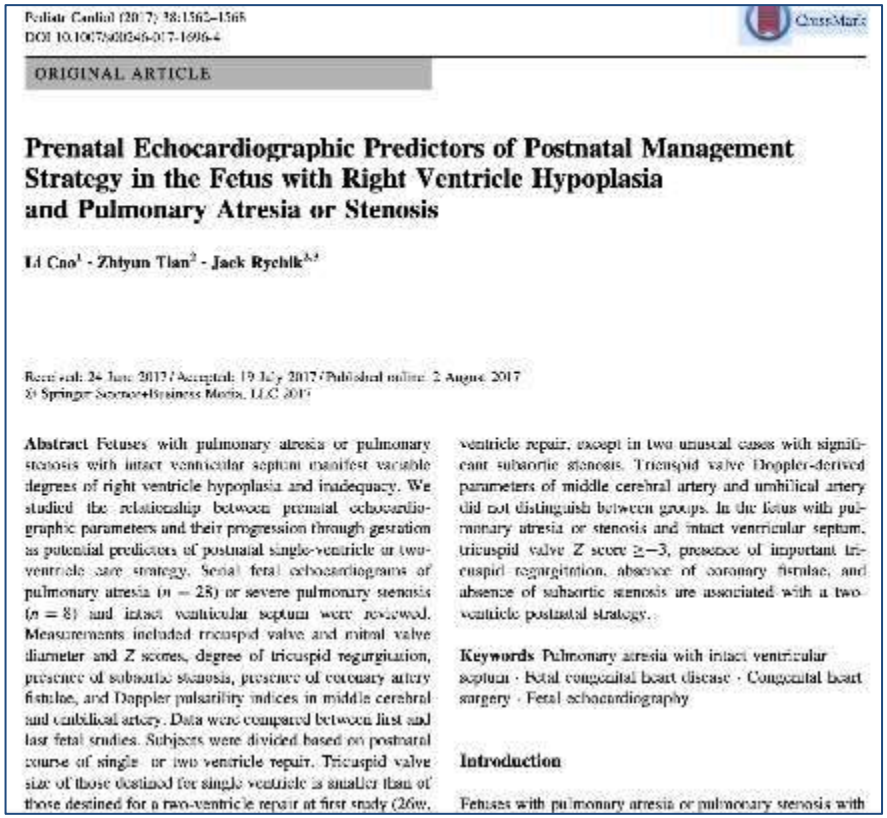
Xiaowei Liu[1] · Yihua He[1] · Zhiyun Tian[2] · Jack Rychik[2]

Received: 9 December 2015 / Accepted: 5 April 2016 / Published online: 15 April 2016

Abstract Ventricular size discrepancy may be due to a persistent left superior vena cava (PLSVC) in utero. We sought to investigate for differences in cardiac structure measures and hemodynamics between fetuses with isolated PLSVC connected to the coronary sinus (CS) and normal. Fetuses diagnosed with isolated PLSVC in the second and third trimester were enrolled. We delineated two groups: group 1, twenty-five fetuses in the second trimester (22 2/7 W + 6d); group 2, twenty-two fetuses in the third trimester (28 3/7 W — 6d). Fifty-three fetuses without intra-cardiac or extra-cardiac anomalies and gestation age-matched were divided into normal control groups: group 3, 28 fetuses in the second trimester; group 4, 25 fetuses in the third trimester. Parameters of cardiac structure and hemodynamics were measured, including left- and right-side heart size, the diameter of foramen ovale, aorta (AO), aortic isthmus and pulmonary artery (PA), and ratios of cardiac structure RV/LV, RA/LA and PA/AO were calculated. Hemodynamic parameters including tricuspid valve and foramen ovale. In the second trimester, the ratio of RV/LV and PA/AO of the PLSVC fetuses was significantly larger than normal, while the AO diameter, aortic isthmus diameter were smaller than normal ($P < 0.05$). However, in the third trimester, only the ratio of PA/AO of the PLSVC fetuses was significantly larger, and the aortic isthmus diameter was still smaller than normal ($P < 0.05$). Isolated PLSVC connecting to the CS is associated with differences in cardiac structure size from normal. These differences appear to diminish with gestational age. A dilated CS may have an influence on development of fetal left heart structures.

Keywords Persistent left superior vena cava · Fetal heart · Fetal echocardiography

Introduction



Pediatr Cardiol (2017) 38:1362–1368
DOI 10.1007/s00246-017-1696-4

ORIGINAL ARTICLE

Prenatal Echocardiographic Predictors of Postnatal Management Strategy in the Fetus with Right Ventricle Hypoplasia and Pulmonary Atresia or Stenosis

Li Cao[1] · Zhiyun Tian[2] · Jack Rychik[2,3]

Received: 24 June 2017 / Accepted: 19 July 2017 / Published online: 2 August 2017

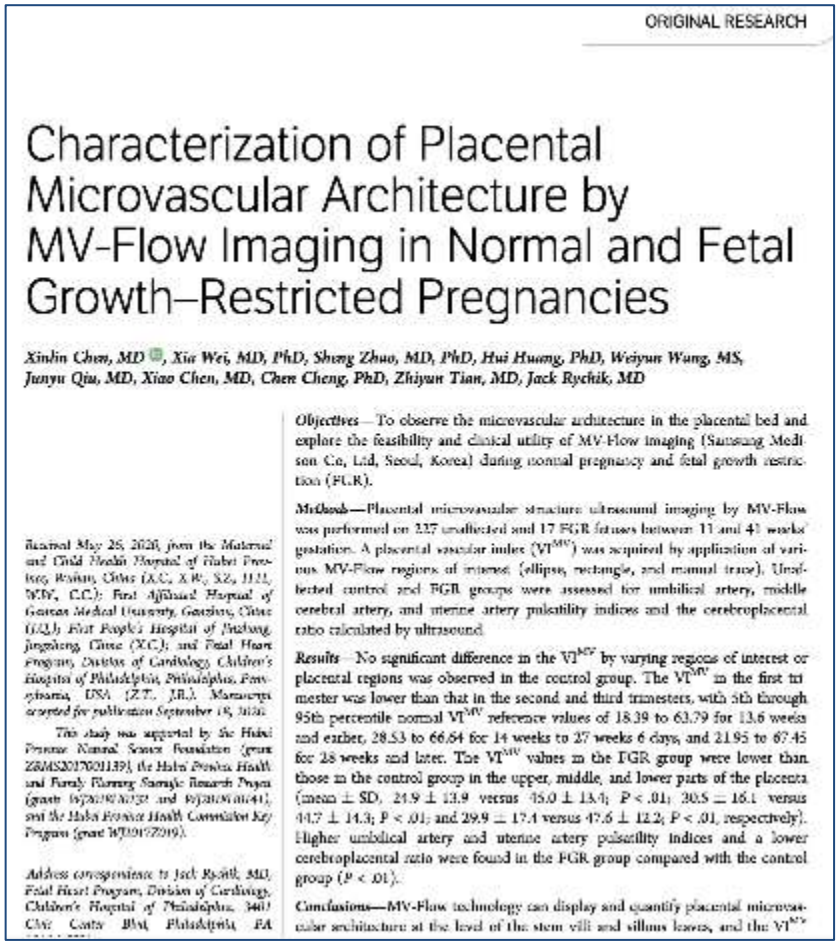
Abstract Fetuses with pulmonary atresia or pulmonary stenosis with intact ventricular septum manifest variable degrees of right ventricle hypoplasia and inadequacy. We studied the relationship between prenatal echocardiographic parameters and their progression through gestation as potential predictors of postnatal single-ventricle or two-ventricle care strategy. Serial fetal echocardiograms of pulmonary atresia ($n = 28$) or severe pulmonary stenosis ($n = 8$) and intact ventricular septum were reviewed. Measurements included tricuspid valve and mitral valve diameter and Z scores, degree of tricuspid regurgitation, presence of subaortic stenosis, presence of coronary artery fistulae, and Doppler pulsatility indices in middle cerebral and umbilical artery. Data were compared between first and last fetal studies. Subjects were divided based on postnatal course of single- or two-ventricle repair. Tricuspid valve size of those destined for single ventricle is smaller than of those destined for a two-ventricle repair at first study (26w, ventricle repair, except in two unusual cases with significant subaortic stenosis. Tricuspid valve Doppler-derived parameters of middle cerebral artery and umbilical artery did not distinguish between groups. In the fetus with pulmonary atresia or stenosis and intact ventricular septum, tricuspid valve Z score ≥−3, presence of important tricuspid regurgitation, absence of coronary fistulae, and absence of subaortic stenosis are associated with a two-ventricle postnatal strategy.

Keywords Pulmonary atresia with intact ventricular septum · Fetal congenital heart disease · Congenital heart surgery · Fetal echocardiography

Introduction

Fetuses with pulmonary atresia or pulmonary stenosis with

Collaboration in Publications



ORIGINAL RESEARCH

Characterization of Placental Microvascular Architecture by MV-Flow Imaging in Normal and Fetal Growth–Restricted Pregnancies

Xinlin Chen, MD, Xia Wei, MD, PhD, Sheng Zhuo, MD, PhD, Hui Huang, PhD, Weiyun Wang, MS, Junyu Qiu, MD, Xiao Chen, MD, Chen Cheng, PhD, Zhiyun Tian, MD, Jack Rychik, MD

Received May 25, 2020, from the Maternal and Child Health Hospital of Hubei Province, Wuhan, China (X.C., X.W., S.Z., H.H., W.W., C.C.); First Affiliated Hospital of Guizhou Medical University, Guiyang, China (J.Q.); First People's Hospital of Jingzhou, Jingzhou, China (X.C.); and Fetal Heart Program, Division of Cardiology, Children's Hospital of Philadelphia, Philadelphia, Pennsylvania, USA (Z.T., J.R.). Manuscript accepted for publication September 18, 2020.

This study was supported by the Hubei Province Natural Science Foundation (grant ZRMS2017001139), the Hubei Province Health and Family Planning Scientific Research Project (grants WJ2019H3052 and WJ2020M041), and the Hubei Province Health Committee Key Program (grant WJ2017Z019).

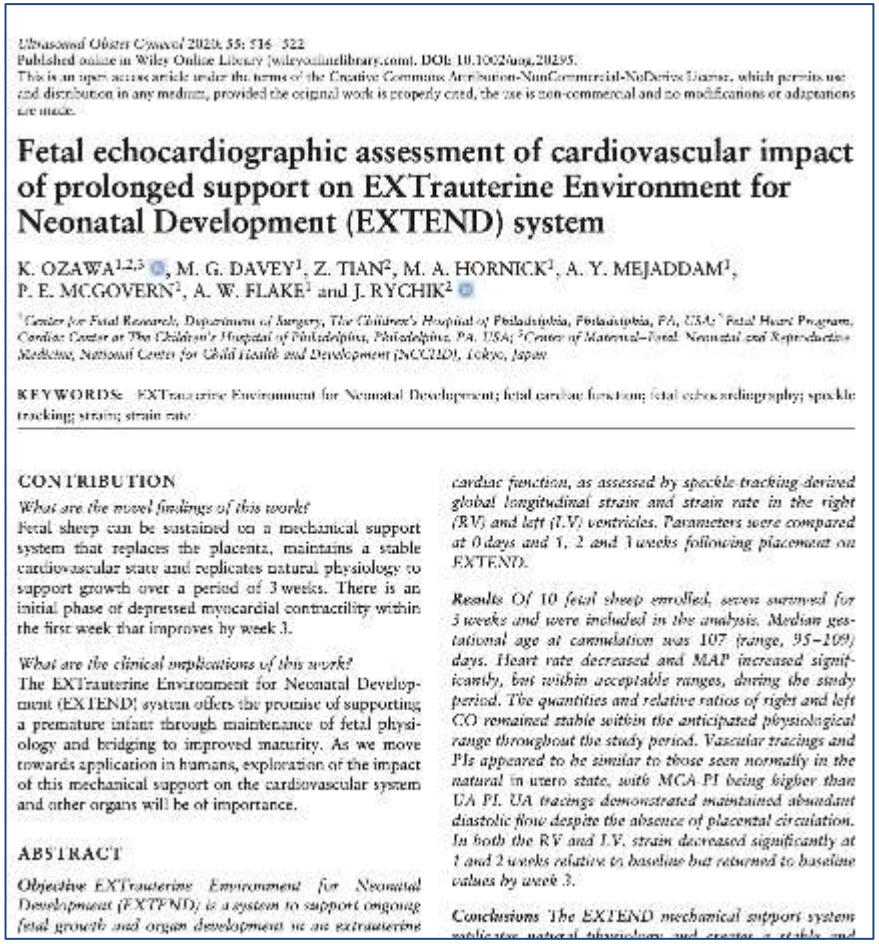
Address correspondence to Jack Rychik, MD, Fetal Heart Program, Division of Cardiology, Children's Hospital of Philadelphia, 3401 Civic Center Blvd, Philadelphia, PA

Objectives—To observe the microvascular architecture in the placental bed and explore the feasibility and clinical utility of MV-Flow imaging (Samsung Medison Co, Ltd, Seoul, Korea) during normal pregnancy and fetal growth restriction (FGR).

Methods—Placental microvascular structure ultrasound imaging by MV-Flow was performed on 237 unaffected and 17 FGR fetuses between 11 and 41 weeks' gestation. A placental vascular index (VI^{MV}) was acquired by application of various MV-Flow regions of interest (ellipse, rectangle, and manual trace). Unaffected control and FGR groups were assessed for umbilical artery, middle cerebral artery, and uterine artery pulsatility indices and the cerebroplacental ratio calculated by ultrasound.

Results—No significant difference in the VI^{MV} by varying regions of interest or placental regions was observed in the control group. The VI^{MV} in the first trimester was lower than that in the second and third trimesters, with 5th through 95th percentile normal VI^{MV} reference values of 18.39 to 63.79 for 13.6 weeks and earlier, 28.53 to 66.64 for 14 weeks to 27 weeks 6 days, and 21.95 to 67.45 for 28 weeks and later. The VI^{MV} values in the FGR group were lower than those in the control group in the upper, middle, and lower parts of the placenta (mean ± SD, 24.9 ± 13.9 versus 45.0 ± 13.4; $P < .01$; 30.5 ± 16.1 versus 44.7 ± 14.3; $P < .01$; and 29.9 ± 17.4 versus 47.6 ± 12.2; $P < .01$, respectively). Higher umbilical artery and uterine artery pulsatility indices and a lower cerebroplacental ratio were found in the FGR group compared with the control group ($P < .01$).

Conclusions—MV-Flow technology can display and quantify placental microvascular architecture at the level of the stem villi and villous leaves, and the VI^{MV}



Ultrasound Obstet Gynecol 2020; 55: 516–522
Published online in Wiley Online Library (wileyonlinelibrary.com). DOI: 10.1002/uog.20295.

Fetal echocardiographic assessment of cardiovascular impact of prolonged support on EXTrauterine Environment for Neonatal Development (EXTEND) system

K. OZAWA[1,2,3], M. G. DAVEY[1], Z. TIAN[2], M. A. HORNICK[1], A. Y. MEJADDAM[1], P. E. MCGOVERN[1], A. W. FLAKE[1] and J. RYCHIK[2]

[1]Center for Fetal Research, Department of Surgery, The Children's Hospital of Philadelphia, Philadelphia, PA, USA; [2]Fetal Heart Program, Cardiac Center at The Children's Hospital of Philadelphia, Philadelphia, PA, USA; [3]Center of Maternal–Fetal, Neonatal and Reproductive Medicine, National Center for Child Health and Development (NCCHD), Tokyo, Japan

KEYWORDS: EXTrauterine Environment for Neonatal Development; fetal cardiac function; fetal echocardiography; speckle tracking; strain; strain rate

CONTRIBUTION

What are the novel findings of this work?
Fetal sheep can be sustained on a mechanical support system that replaces the placenta, maintains a stable cardiovascular state and replicates natural physiology to support growth over a period of 3 weeks. There is an initial phase of depressed myocardial contractility within the first week that improves by week 3.

What are the clinical implications of this work?
The EXTrauterine Environment for Neonatal Development (EXTEND) system offers the promise of supporting a premature infant through maintenance of fetal physiology and bridging to improved maturity. As we move towards application in humans, exploration of the impact of this mechanical support on the cardiovascular system and other organs will be of importance.

ABSTRACT

Objective *EXTrauterine Environment for Neonatal Development (EXTEND) is a system to support ongoing fetal growth and organ development in an extrauterine cardiac function, as assessed by speckle tracking derived global longitudinal strain and strain rate in the right (RV) and left (LV) ventricles. Parameters were compared at 0 days and 1, 2 and 3 weeks following placement on EXTEND.*

Results *Of 10 fetal sheep enrolled, seven survived for 3 weeks and were included in the analysis. Median gestational age at cannulation was 107 (range, 95–109) days. Heart rate decreased and MAP increased significantly, but within acceptable ranges, during the study period. The quantities and relative ratios of right and left CO remained stable within the anticipated physiological range throughout the study period. Vascular tracings and PIs appeared to be similar to those seen normally in the natural in utero state, with MCA PI being higher than UA PI. UA tracings demonstrated maintained abundant diastolic flow despite the absence of placental circulation. In both the RV and LV, strain decreased significantly at 1 and 2 weeks relative to baseline but returned to baseline values by week 3.*

Conclusions *The EXTEND mechanical support system*

Future Initiative Vision

- Expand training programs
- Foster deeper international collaborations
- Continue to innovate in fetal cardiovascular imaging
- Ongoing global sharing of expertise to further improve patient care worldwide