KSC 2022 DAILY

Today's Highlights

기획세션 1~5
09:00-18:10 / Rm.325AB

Cross Specialty 1: Arrhythmia & Intervention
Management of Conduction Disturbances after TAVR
10:40-12:10 / Rm.324

Cross Specialty 2: Gastroenterology & Intervention
Cardiology Meets Gastroenterology
13:20-14:50 / Rm.325CD

Cross Specialty 3: CTEPH
Chronic Thromboembolic Pulmonary Disease - Recent Advances with Paradigm Shift
13:20-14:50 / Rm.324

Cross Specialty 4: Intervention & Heart Failure & Cardiac Surgery
Contemporary Comprehensive Treatment in Advanced Heart Failure
15:00-16:30 / Rm.323

ESC-KSC Joint Session: Echocardiography
Benefits of Having It 'Big': Perspectives in Imaging & EchoCG
16:40-18:10 / Rm.323

Welcome Message

Myeong-Chan Cho, MD, PhD
Chairperson, The Korean Society of Cardiology

It is my great pleasure to announce the hosting of the 66th Annual Scientific Meeting of the Korean Society of Cardiology (KSC 2022) to be held from September 23 to 25, 2022 at EXCO in Daegu, Korea.

For the last 2 years, it was inevitable to hold our scientific meetings in a virtual platform due to COVID-19. However, we finally meet in person to share the latest knowledge and to present research findings this year. I would like to express respect and gratitude to all of you, as this meeting and gathering is possible with your continued efforts, research, and hard work for finding the best treatments for patients.

As caution should still be taken with the COVID-19 pandemic, we prepared and organized various programs considering the safety of the participants to continue to inspire the academic passion. There will be programs from guideline updates to clinical practice sharing, including various cross specialty sessions with gastroenterology, endocrinology, and artificial intelligence and more, which will bring you new perspectives and knowledge through KSC 2022.

I hope all participants will enjoy their time at KSC 2022, exchanging various academic contents and building strong relations with each other. I look forward to having you all at KSC 2022.

Hyo-Soo Kim, MD, PhD
President & CEO, The Korean Society of Cardiology

On behalf of The Korean Society of Cardiology, I am honored and pleased to welcome all of attendees at KSC 2022 (The 66th Annual Scientific Meeting of The Korean Society of Cardiology), held on September 23rd-25th at EXCO in Daegu, Korea.

This year, we have organized 84 symposiums with 293 faculties from 11 countries. Selected through our review process, 385 oral presentations, 35 cases and 50 e-posters will be presented during our meeting. I hope it will be a very fruitful meeting with the contribution from all faculties and presenters.

The organizing committee has gone to great lengths to plan a meaningful meeting and to ensure the attendees to be satisfied. This meeting aims to explore the latest research findings and to share an insight into the latest discoveries and cutting-edge scientific opinions with healthcare professionals in the field of cardiology.

To awaken the interest in all the field of cardiology, from the basic to clinical research, we have organized 'Basic Research Hot Session' with the latest studies from world-renowned cardiologists. You will also have the opportunity to dive into the immensely updated contents of guideline at the Guideline Review Session.

As there are various sub-specialties in the field of cardiology, we prepared Cross Specialty Sessions to discuss and debate interactively on the latest issues with the professionals from different sub-specialties.

Since it has been 2 years holding an onsite meeting due to the COVID-19 pandemic, I hope it will be a chance for everyone to meet in person and actively interact with one another.

KSC 2022 DAILY

Program at a glance: Day 1, Sep 23, 2022

Time	Rm. 325AB	Rm. 325CD	Rm. 324	Rm. 323	Rm. 322	Rm. 321	Rm. 320	Rm. 306A	Rm. 306B	Rm. 315	Grand Ballroom		
											Zone A	Zone B	Zone C
09:00-10:30	기획세션 1: 새싹연구자를 위한 임상연구입문 101 새싹연구자를 위한 임상연구입문 101	Intervention 1 CTO Recorded Live Session	Arrhythmia 1 Basic EP (Including Recorded Live Session)	Young Investigator award Competition 1 1-6	Young Investigator award Competition 2 7-12	Echocardiography 1 Cardio-oncology, How to Evaluate	전공의 Award - Oral 1-4	CAD 1 1-8	Arrhythmia 1 9-16	Basic Research 1 17-24	E-Poster 1-50 (09:00-12:10)		
10:40-12:10	기획세션 2: 내과전공의를 위한 심전도 시리즈 내과 전공의를 위한 심전도 코스	Intervention 2 TAVR Recorded Live Session	Cross Specialty 1: Arrhythmia & Intervention Management of Conduction Disturbances after TAVR	Young Investigator award Competition 3 13-18	Young Investigator award Competition 4 19-24	Cardiac Surgery Diagnosis and Management of Calcific Mitral Stenosis and Mitral Annular Calcification	전공의 Award - Case 5-13	CAD 2 25-32	Arrhythmia 2 33-40	Basic Research 2 41-48			
12:20-13:00	Scientific Session [Viatris] Basic EP Proved Statin with Proved Evidence; Atorvastatin for Secondary Prevention	Scientific Session [Organon] Early & Lower for Longer	Scientific Session [BMS/Pfizer] Latest Insights of Anticoagulation Management	Scientific Session [Samjin] Updates on Manage of Cardiovascular Disease	Scientific Session [Hanmi] Optimal Combination Therapy for CV Protection in Hypertensive and Dyslipidemia						Mini Oral 1 (CAD) 1-5	Mini Oral 2 (Intervention) 6-10	Mini Oral 3 (Arrhythmia) 11-15
13:00-13:20	Break												
13:20-14:50	기획세션 3: 국내 심혈관 정책 Emergency Cardiac Care in Korea: Where Are We in 2022?	Cross Specialty 2: Gastroenterology & Intervention Cardiology Meets Gastroenterology	Cross Specialty 3: CTEPH Chronic Thromboembolic Pulmonary Disease - Recent Advances with Paradigm Shift	Echocardiography 2 Guideline Update, A Primer to Imaging Specialists	Cardiac Pathology Cardiac Allograft and Xenograft: Recent Advance and Pathology Review	Cardiometabolic Syndrome 1 Leading Edge on Diet in Cardiometabolic Syndrome	전임의 Award 1 1-8	Case 1 (Pediatric Cardiology & Heart Failure) 1-7	Case 2 (Intervention) 8-15	Case 3 (Arrhythmia) 16-23	E-Poster 1-50 (13:20-18:10)		
15:00-16:30	기획세션 4: Connected Health Connected Health: Current and Future	Myocardial Infarction 1 Updating Knowledge and Implementation in Practice	Arrhythmia 2 Advanced EP (Including Recorded Live Session)	Cross Specialty 4: Intervention & Herat Failure & Cardiac Surgery Comtemporary Comprehensive Treatment in Advanced Heart Failure	Cardiometabolic Syndrome 2 Doubting Routine	Basic Research 1 Innovative Biomedical Engineering Research for Cardiovascular Disease	전임의 Award 2 9-16	CAD 3 49-56	Intervention 1 57-64	Lipid 65-72			
16:40-18:10	기획세션 5: Guideline Review Guideline Review	Myocardial Infarction 2 Beyond the Coronary Arteries in AMI	Arrhythmia 3 Catheter Ablation for Atrial Flutter	ESC-KSC Joint Session (Echocardiography) Benefits of Having It 'Big': Perspectives in Imaging & EchoCG	Meet the Editor Publish or Perish - Insights from the Editors	Basic Research 2 심장기초연구 입문자를 위한 새로운 연구기법 소개		Intervention 2 73-80	Heart Failure 1 81-88	Imaging 89-96			

Scientific Session

Scientific Session [Viatris]

Proved Statin with Proved Evidence; Atorvastatin for Secondary Prevention

12:20-12:40	Ideal Treatment for High Risk Patients; Earlier with High Intensity Statin for CHD Prevention
12:40-13:00	HEADS-UP: Worth the Statin with Safety for ASCVD Patient

›› Sep 23, 12:20-13:00, 325AB

Scientific Session [Organon]

Early & Lower for Longer

12:20-12:40	Early for Longer: Intensive Lipid Lowering - Moving Beyond Statins Alone
12:40-13:00	Lower for Longer: Effective Lipid Lowering - Rising on Ezetimibe Therapy

›› Sep 23, 12:20-13:00, 325CD

Scientific Session [BMS/Pfizer]

Latest Insights of Anticoagulation Management

12:20-12:40	Optimizing Clinical Practice: Focus on 2022 KHRS Guideline Update
12:40-13:00	Challenges and Advances in VTE Special Population: Aged, Renal and Cancer

›› Sep 23, 12:20-13:00, 324

Scientific Session [Samjin]

Updates on Manage of Cardiovascular Disease

12:20-12:40	Strategy of Anti-Platelet Therapy after PCI in High-Risk Patients
12:40-13:00	Rivaroxaban and the Future of SPAF in Patients of AF

›› Sep 23, 12:20-13:00, 323

Scientific Session [Hanmi]

Optimal Combination Therapy for CV Protection in Hypertensive and Dyslipidemia

12:20-12:40	Combination Therapy of Antihypertensive Drugs for CV Protection
12:40-13:00	Moderate-intensity Statin with Ezetimibe Combination Therapy, an Alternative Strategy for ASCVD Patients; Results from the RACING Trial

›› Sep 23, 12:20-13:00, 322


Young Investigator award
Competition
Day 1 (9/23, Fri.)
09:00 - 12:10, Rm. 323 & 322


APSC 2025 &
Asian Pacific Society of Cardiology Congress 2025
2025 Annual Spring Scientific Conference of the
KSC with Affiliated Cardiac Societies
April 18(Fri.) - 19(Sat.), 2025
BEXCO, Korea


edarbi
Power
Control
Consistent 24h BP control[1]
Reference 1. William B. White, et al. Effects of the Angiotensin Receptor Blocker Azilsartan Medoxomil Versus Olmesartan and Valsartan on Ambulatory and Clinic Blood Pressure in Patients With Stages 1 and 2 Hypertension. Hypertension 2011;57:413-420.
* 이 내용은 허가사항을 요약한 것으로 자세한 정보는 제품의 첨부문서 또는 http://nedrug.mfds.go.kr를 확인하십시오.
DONG-A ST
셀트리온제약
CELLTRION
edarbi
azilsartan medoxomil
40 mg • 80 mg tablets
OT2021-19


First* and only[1,2,#,†]
아토르바스타틴과 유일한 오리지널 에제티미브† 복합제
아토젯® 으로 고지혈증 환자의
치료를 시작해주세요.[1,2]
ATOZET
Atozet®
(ezetimibe and atorvastatin, MSD)
MSD
ORGANON

Guideline Review

2021 AHA/ACC/ASE/CHEST/SAEM/SCCT/SCMR Guideline for the Evaluation and Diagnosis of Chest Pain

Young Joon Hong, MD, PhD
Chonnam National University Hospital, Korea

Chest pain is a frequent cause for emergency department visits all over the world. Recently, guideline for the evaluation and diagnosis of chest pain was published by the Journal of the American College of Cardiology (JACC; Gulati et al. J Am Coll Cardiol 2021;78:e187–e285). The **"2021 AHA/ACC/ASE/CHEST/SAEM/SCCT/SCMR Guideline for the Evaluation and Diagnosis of Chest Pain"** provides recommendations based on contemporary evidence on the assessment and evaluation of chest pain. This guideline presents an evidence-based approach to risk stratification and the diagnostic workup for the evaluation. Cost-value considerations in diagnostic testing have also been incorporated, and shared decision-making with patients is recommended.

Below are TOP 10 TAKE-HOME MESSAGES created by taking the first letter FOR THE EVALUATION AND DIAGNOSIS OF CHEST PAIN (Figure 1).

1. Chest Pain Means More Than Pain in the Chest. Pain, pressure, tightness, or discomfort in the chest, shoulders, arms, neck, back, upper abdomen, or jaw, as well as shortness of breath and fatigue should all be considered anginal equivalents.

Figure 1. Evaluation and diagnosis of chest pain (J Am Coll Cardiol 2021;78:e187–e285)

2. High-Sensitivity Troponins Preferred. High-sensitivity cardiac troponins are the preferred standard for establishing a biomarker diagnosis of acute myocardial infarction, allowing for more accurate detection and exclusion of myocardial injury.

3. Early Care for Acute Symptoms. Patients with acute chest pain or chest pain equivalent symptoms should seek medical care immediately by calling 9-1-1. Although most patients will not have a cardiac cause, the evaluation of all patients should focus on the early identification or exclusion of life-threatening causes.

4. Share the Decision-Making. Clinically stable patients presenting with chest pain should be included in decision-making; information about risk of adverse events, radiation exposure, costs, and alternative options should be provided to facilitate the discussion.

5. Testing Not Needed Routinely for Low-Risk Patients. For patients with acute or stable chest pain determined to be low risk, urgent diagnostic testing for suspected coronary artery disease is not needed.

6. Pathways. Clinical decision pathways for chest pain in the emergency department and outpatient settings should be used routinely.

7. Accompanying Symptoms. Chest pain is the dominant and most frequent symptom for both men and women ultimately diagnosed with acute coronary syndrome. Women may be more likely to present with accompanying symptoms such as nausea and shortness of breath.

8. Identify Patients Most Likely to Benefit From Further Testing. Patients with acute or stable chest pain who are at intermediate risk or intermediate to high pretest risk of obstructive coronary artery disease, respectively, will benefit the most from cardiac imaging and testing.

9. Noncardiac Is In. Atypical Is Out. "Noncardiac" should be used if heart disease is not suspected. "Atypical" is a misleading descriptor of chest pain, and its use is discouraged.

10. Structured Risk Assessment Should Be Used. For patients presenting with acute or stable chest pain, risk for coronary artery disease and adverse events should be estimated using evidence-based diagnostic protocols.

Chest pain is one of the most common symptoms for which a person seeks medical care. Chest pain is often difficult to diagnose and can be a source of embarrassment to doctors. According to the current guideline, we should try to evaluate and diagnose patients with chest pain more carefully and accurately.

기획세션 5: Guideline Review
Guideline Review
›› Friday, Sep 23, 16:40-18:10, 325AB

Cardiometabolic Syndrome

Suk Chon, MD, PhD
Kyung Hee University Hospital, Korea

Intermittent Fasting in Diabetes/Prediabetes

Intensive diet intervention is the primary treatment for preventing and managing metabolic diseases such as obesity, diabetes, and hyperglycemia. However, these diet interventions are challenging for most people to maintain because they must regularly consume adequate calories or reduced calories every day and continue for a long time. Intermittent fasting (IF), which has become very popular over the past few years, is a generic term for various eating methods involving fasting for different periods, such as several hours a day, 1 day every several days, or several days a week. Many people are interested in IF because they fast only for a certain period, and it does not require a continuous diet control.

In some studies, IF is known to be effective in preventing diabetes, cardiovascular disease, cancer, and degenerative brain disease, and in weight loss in overweight or obese people. However, these studies were conducted in a short period with a small number of subjects, and the results were heterogeneous between studies. In addition, it is known that it is difficult to apply IF to patients with cardio-metabolic diseases such as morbid obesity, diabetes, and hypertension, as most of the studies evaluated the effect on healthy adults.

Nevertheless, as public interest increases and the number of people who tried IF increases, patients with metabolic diseases are also exposed to the risk of various side effects from IF. Korean Diabetes Association and related academic society conducted this research to reduce the poten-

Continued on page 5

Cross Specialty 2: Gastroenterology & Intervention

Cardiology Perspective

Chung Ki Kim, MD, PhD
Ewha Womans University Seoul Hospital, Korea

Antithrombotic therapy (ATT) including antiplatelet and anticoagulation therapy has been identified to prevent ischemic adverse event in patients with atherosclerotic disease or atrial fibrillation. Many investigations have warned the risk of inappropriate discontinuation of ATT. However, there are inevitable needs for withdrawal of ATT before undergoing procedures that are associated with high bleeding risk, where lies a risk of significant increase in blood loss with ATT and difficulty to control procedure-related bleeding at critical or obscure site(s). **Current guidelines stress on maintaining ATT during endoscopy procedures with low bleeding risk or elective setting** (**Figure 1**)**.** Many observation studies reported that the risk of clinically significant bleeding with diagnostic endoscopic procedures including standard biopsies is very low. In a randomized controlled trial comparing aspirin and clopidogrel in 45 healthy volunteers undergoing multiple gastroduodenal biopsies, only one of the 630 biopsies led to one minor endoscopic bleeding without clinical event. High risk procedures such as ESD, EUS-FNA, and PEG/PEJ placement may require complete or partial restoration of platelet or coagulation function. However, there is no clear definition of high-risk endoscopic procedures that should be performed without ATT and the recommendations in the current guidelines have been mostly based on the limited evidence. There is no evidence to confidently estimate the risk of procedure-related bleeding with uninterrupted ATT. According to a prospective observation study (the PARIS registry) including patients undergoing percutaneous coronary intervention (PCI), physician-guided brief interruption of dual antiplatelet therapy (DAPT) for surgery occurred in 11% of patients without an increase in major adverse cardiac event. Overall unguided disruption (non-compliance or because of bleeding) of DAPT was not rare (14%) and associated with a significant increase in cardiac events. Although it may not be realistic to precisely estimate the increase in ischemic risk with brief cessation of ATT for each patient, absolute degree of harm regarding ischemic risk, even if very subtle, would be much greater than that of potential benefit accompanied with withdrawal of ATT considering the type of associated adverse events. **Close collaboration between the cardiologist and endoscopist to carefully review and consider clinical information regarding the need for ATT and bleeding risk with a procedure would be desirable for the most optimal management of ATT.** For high-risk procedures in patients with high ischemic risk, bridging therapy would be one of possible options for patients with heparinization or intravenous Cangrelor with a rapid onset and offset of action (which is not available in Korea currently).

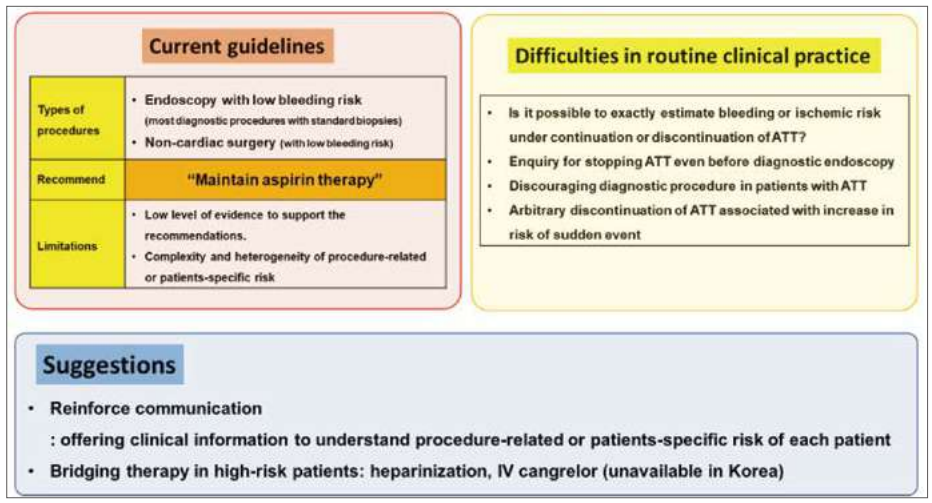

Figure 1. Current guidelines, routine clinical practice, and future directions

Gastroenterology Perspective

이준행 교수
성균관의대 삼성서울병원

관상동맥스텐트 시술 후 6-12개월 동안 아스피린과 clopidogrel 두 가지를 사용하는 dual antiplatelet therapy가 시행되지만 스텐트 시술 후 6개월 이후, 특히 12개월 이후에는 안전하게 중지할 수 있다. 최근에는 보다 짧은 기간 사용 후 중단하기도 한다. 관찰만 시행하는 위내시경 검사나 조직검사까지는 항혈소판제나 항응고제 중단 없이 시술이 가능하다. 고위험 시술에서는 적절한 기간 후에 중단해야 한다. 우리나라에서는 약제를 중단하지 않아도 되는 상황에서 약제를 중단하거나, 필요 이상으로 오래 중단하는 경우가 많다. 의료계의 관행과 더불어 영어와 우리말의 영어 표현의 문제도 관여된다. 아스피린, 와파린, NOAC 사용 환자의 내시경 시술에 대한 지침은 계속 변경되고 있다. 이번 강의에서 제시되는 방법은 가까운 과거나 현재에는 타당할지라도 가까운 미래에 변경될 가능성이 있다. 임상 현장에서는 새롭게 제시되는 의료정보와 가이드라인을 실시간으로 반영한 개별화된 정책이 사용되어야 할 것이다.

Cross Specialty 2: GI & Intervention
Cardiology Meets Gastroenterology
›› Friday, Sep 23, 13:20-14:50, 325CD

Continued from page 4

tial harm caused by IF and to recommend clear guidelines.

In recommendations published throughout the study, IF was strongly recommended not to be performed in adults with type 2 diabetes and prediabetes due to the lack of evidence of benefit and harm, and the risk of hypoglycemia [Strong Recommendation, Low quality of evidence]. In this session, the results of a systematic review and meta-analysis on the effects of IF in type 2 diabetes and prediabetes will be presented.

Low Carbohydrate Diet in Hypertension

Hyo-Suk Ahn, MD, PhD
The Catholic University of Korea Uijeongbu St. Mary's Hospital, Korea

A low carbohydrate diet naturally leads to weight loss and improved glycemic control, which in turn has a positive effect on blood pressure control and cardiovascular events. Therefore, it is clear that a low carbohydrate diet is necessary to prevent metabolic syndrome. This is similar to saying that a low calorie diet helps prevent metabolic syndrome. However, **a low carbohydrate, high fat diet is a more complex issue and will require more consideration in especially hypertension control**. A variety of dietary modifications are beneficial in the treatment of hypertension, including reduction of sodium intake, moderate consumption of alcohol, weight loss in the overweight or obese, and a diet rich with fruits, vegetables, legumes, and low-fat dairy products low in snacks, sweets, meat, and saturated fat. Individual dietary factors may also reduce blood pressure. This presentation plans to examine the relationship between a low carbohydrate diet and blood pressure control through the results of several studies. The effects of low fat, high carbohydrate diets vs. low carbohydrate, high fat diets on systolic blood pressure and diastolic blood pressure are controversial in these studies. Both diets are effective for weight control and reduction of cardiovascular risk factors. Further studies with long-term follow-up are needed to confirm the current understanding.

Cardiometabolic Syndrome 1
Leading Edge on Diet in Cardiometabolic Syndrome
›› Friday, Sep 23, 13:20-14:50, 321

KSC 2022 DAILY

Echocardiography

Cardio-oncology, How to Evaluate using Echocardiography

In Ki Moon, MD
Soonchunhyang University Bucheon Hospital, Korea

Cardiovascular disease (CVD) and cardiovascular complications in cancer patients is a growing medical problem, especially with the growing number of chemotherapeutic agents. **Cardiovascular imaging is a valuable modality to evaluate and monitor the at-risk patients, helping to distinguish cancer patients who may benefit from cardioprotective treatments while on cancer therapy.** Similar to general cardiovascular care, echocardiography plays a central role in the field of cardio-oncology. Although the reduction of left ventricular ejection fraction (LVEF) is crucial for cardiotoxicity evaluation, it is well-known in contemporary cardiology that LVEF has inherent limitations in recognizing early myocardial dysfunction due to its temporal and operator variability. Three-dimensional (3D) echocardiography could be utilized to reduce inter- and intra-observer variability. Global longitudinal strain (GLS), which reflects subclinical ventricular dysfunction, demonstrates better associations with prognosis than LVEF in other cardiac diseases. LVGLS could contribute to early detection of cardiotoxicity and guide the timing of cardioprotective treatment during cancer therapy (**Figure 1**). Moreover, markers of right ventricular systolic function (TAPSE, FAC, RV strain, and RVEF), tricuspid regurgitation velocity, and inferior vena cava diameter have also gained attention recently (**Table 1**).

The Imaging and Cardio-Oncology Study Groups of the Heart Failure Association of the European Society of Cardiology recently published a position paper on the role of cardiovascular imaging in cancer patients on cardiotoxic therapies. This session will focus on reviewing and discussing the suggested surveillance algorithms for various cancer therapies to improve current practice with representative cases.

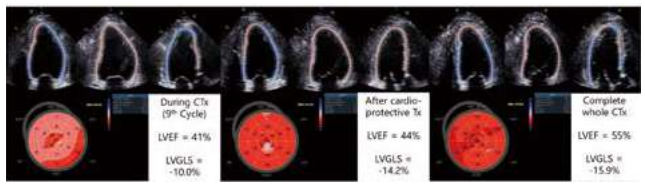

Figure 1. A case of a 53-year-old female who had a history of right breast ductal carcinoma (ER- HER2+) treated with doxorubicin, cyclophosphamide, docetaxel, and trastuzumab

Echocardiography 1
Cardio-oncology, How to Evaluate
›› Friday, Sep 23, 09:00-10:30, 321

Table 1. Valuable echocardiographic parameters for cardio-oncology surveillance (Eur J Heart Fail 2020;22:1504-1524)

Parameters	Clinically significant changes	Comments
LV size and function		
LVEF by Simpson's 2D, or (semi) automatic 3D	Drop >10% (percentage points) for 2D, >5% for 3D from pre-treatment value	Decline of LVEF to value <40–50% suggests initiation of cardioprotection
2D/3D GLS, GCS	Relative reduction by >10–15% from pre-treatment value and to below lower limit of normal	Average from three apical views; do not use single-view value
LV 2D/3D systolic and diastolic volumes	Increase by 15 mL for ESV, 30–35 mL for EDV	Increase in volumes reflects remodelling and fluid status
RV function, pulmonary artery pressure and volaemia		
Markers of systolic RV function	TAPSE <1.7 cm, FAC <35%, RV free wall strain <20%, 3D RVEF <45%	Show prognostic value in heart failure and pulmonary hypertension
Velocity of TR	Peak systolic TR velocity > 2.8 m/s	Indicates probable pulmonary hypertension
IVC diameter, collapse on inspiration	Dilatation >2.1 cm or narrowing <1.3 cm	Relates to hypervolaemia or dehydration, respectively

Guideline Update in Heart Failure

Ju-Hee Lee, MD, PhD
Korea National Institute of Health & Chungbuk National University Hospital, Korea

The updated universal definition of heart failure (HF) is "symptoms and/or clinical signs caused by a structural and/or functional cardiac abnormality, corroborated by either elevated natriuretic peptide levels or objective evidence of cardiogenic pulmonary or systemic congestion". The most recently updated guidelines emphasize the role of HF primary prevention, such as lifestyle modification, screening, and management of risk factors and comorbid conditions, for those at risk (stage A) or pre-HF (stage B). Echocardiography is a key modality to evaluate the structural and functional cardiac abnormalities. Because signs and symptoms can be nonspecific, supporting evidence of increased filling pressures, either invasive or noninvasive, are required for confirmative diagnosis when the ejection fraction (EF) is >40%. Heart failure can be classified by EF (**Figure 2**). All patients with current or prior HF, irrespective of the EF, should be considered for guideline-directed medical therapy (GDMT), which has been expanded into four classes: 1) renin-angiotensin system inhibition (RASi) with angiotensin receptor-neprilysin inhibitors (ARNi), angiotensin-converting enzyme inhibitors (ACEi), or angiotensin (II) receptor blockers (ARB) alone; 2) beta blockers; 3) mineralocorticoid receptor antagonists (MRA); and 4) sodium-glucose cotransporter-2 inhibitors (SGLT2i). ARNi is now recommended as the first-line RASi to reduce morbidity and mortality in HFrEF. New recommendations were made for the use of SGLT2i in HF. In symptomatic patients with chronic HFrEF, SGLT2i reduces hospitalization and cardiovascular mortality, regardless of type 2 diabetes. SGLT2i can also be beneficial in patients with HFmrEF and HFpEF.

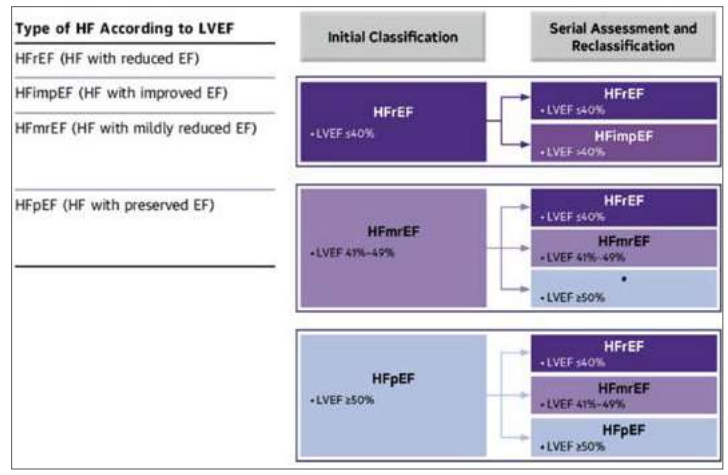

Figure 2. Classification of heart failure by LVEF (J Am Coll Cardiol 2022;79:e263-e421; Circulation 2022;145:e895-e1032; J Card Fail 2022;28:e1-e167)

With advances in cardiac imaging and biomarkers, stage B pre-HF will be likely to increase. Therefore, identifying structural abnormalities (e.g., reduced EF or strain, ventricular hypertrophy, chamber enlargement) and/or evidence for increased filling pressure by Doppler echocardiography is essential for imaging specialists. Additionally, imaging specialists should seek for specific cause of HF because appropriate treatment may be determined by the cause (e.g., cardiac amyloidosis).

Several guidelines for the diagnosis and management of HF have recently been released from the US (2022), Europe (2021), Japan (2021) and Korea (2022). During this session, the major updates of HF guidelines will be reviewed with a focus on 2022 ACC/AHA and 2021 ESC guidelines, especially focusing on their implications for imaging specialists.

Echocardiography 2
Guideline Update, A Primer to Imaging Specialists
›› Friday, Sep 23, 13:20-14:50, 323

Myocardial Infarction

Timing of Mechanical Circulatory Support in AMI with Cardiogenic Shock

Min Chul Kim, MD, PhD
Chonnam National University Hospital, Korea

The use of mechanical circulatory support (MCS) is increasing worldwide to treat acute myocardial infarction (AMI) patients with profound cardiogenic shock (CS). Despite its increasing utilization rate, the timing, indication and prognostic impact on clinical outcomes are still controversial. **The timing of MCS is one of the most important factors that impacts clinical outcome.** Theoretically, MCS before revascularization can reduce reperfusion injury, and thus, encouraging complete revascularization in extreme situation. Reasons for MCS after revascularization are as follows: i) MCS before revascularization would cause unacceptable delay in percutaneous coronary intervention (PCI), ii) the patient's condition can improve with PCI, and iii) the time difference between pre- and post-PCI MCS will be significantly less than the timing of current clinical practices. In observational studies, the use of veno-arterial extracorporeal membrane oxygenation (VA-ECMO) before PCI was associated with lower in-hospital mortality in patients with AMI-CS, or those that underwent cardiopulmonary resuscitation (CPR). However, there have been few randomized controlled trials regarding this topic. Only one randomized trial (the ARREST trial) proved the benefit of extracorporeal CPR compared with conventional CPR in patients with out-of-hospital cardiac arrest and refractory ventricular fibrillation. A pilot randomized trial compared medical therapy (n=21) to VA-ECMO (n=21) in patients with AMI-CS undergoing early revascularization, and there were no differences in terms of left ventricular ejection fraction, survival rate and neurologic outcomes. For patients with AMI-CS, several randomized trials are exploring whether MCS can reduce mortality in patients with AMI and CS. The ECLS-SHOCK and EURO-SHOCK trials are testing the impact of VA-ECMO in patients with AMI-CS. The difference between the two trials is the timing of VA-ECMO. The ECLS-SHOCK trial is designed to implement VA-ECMO prior to PCI, while the EURO-SHOCK trial is implementing it post-PCI. The DanGer Shock trial is a trial comparing early Impella before revascularization to revascularization only. Finally, the ANCHOR trial is enrolling patients with AMI-CS to compare optimal medical therapy to VA-ECMO with intra-aortic balloon pump.

This session will summarize and present numerous factors, including patients' characteristics and complexity of coronary artery lesions, to be considered when deciding the timing to apply MCS in patients with AMI-CS. The results of ongoing trials would give us valuable information for optimal management of patients with AMI-CS.

Myocardial Infarction 1
Updating Knowledge and Implementation in Practice

›› Friday, Sep 23, 15:00-16:30, 325CD

Novel Interventional Methods to Reduce Infarct Size

이장훈 교수
경북대학교병원

급성심근경색증의 심근경색 크기를 줄이기 위한 새로운 중재치료기법이 기대와 우려 속에 진행 중이다.

지난 수년간 일차적 관상동맥중재시술은 ST분절상승 심근경색증 환자의 사망률을 현저히 감소시켜왔다. 하지만 관상동맥중재시술의 비약적인 발전에도 불구하고 심인성쇼크, 심부전, 심근경색증 후 사망은 여전히 높은 빈도로 발생하고 있어 심근경색증의 최근 사망률은 연간 7-8%로 답보 상태를 보이고 있다. 이는 여전히 불완전한 재관류에 의한 심근손상이 많이 발생하고 이로 인해 심근경색의 크기가 증가하기 때문이다. 심근경색의 크기와 미세혈관손상의 범위가 넓을수록 심근경색 후 생존자의 장기예후도 불량해진다. 최근 보고에 따르면, 심근경색증 발생 첫 1년 안에 약 20%의 환자에서 심부전으로 인한 재입원이 발생하고 있다. 이는 장기적인 측면에서 심근경색증으로 인한 사회경제적 비용이 증가함을 의미한다. 따라서, 심근경색증 환자의 예후개선을 위해서는 심근경색증의 병태생리에 따른 치료적 접근이 필요하다. 일차적 관상동맥중재시술은 급성심근경색증의 가장 중요한 시술적 치료로, 이 과정에서 발생하는 1) 원위부 동맥경화성 혈전에 의한 색전증, 2) 심근허혈/재관류 손상, 3) 관상동맥 미세혈관기능 저하가 심근경색증의 크기와 예후를 결정하는 가장 큰 원인으로 밝혀지고 있다. 따라서, 심근경색증의 예후개선을 위해서는 관상동맥중재시술 과정에서 새로운 치료법이 불가피하다. 최근 개발되어 임상에서 연구되고 있는 새로운 중재시술 기법은 아래와 같이 정리해 볼 수 있다(**Table 1**). 이번 강의에서는 이러한 새로운 기법이 좋은 임상결과로 이어질 수 있을지 고찰해 보고자 한다.

Myocardial Infarction 2
Beyond the Coronary Arteries in AMI

›› Friday, Sep 23, 16:40-18:10, 325CD

Table 1. Summary of novel interventional methods in STEMI (J Cardiovasc Dev Dis 2021;8:100)

Treatment	Study	No.	Condition	Intervention	Primary Endpoint	Estimated Completion Date
Preventing distal embolization						
Sono thrombolysis	RCT SONOSTEMILYSIS trial	60	High-risk STEMI (>2 mm in ECG) undergoing fibrinolysis Timing: average 15 min before & after PCI	Diagnostic ultrasound with contrast agent plus HMI pulses vs. diagnostic ultrasound plus standard therapy alone	Complete ST-segment resolution 90 min post-fibrinolysis	May 2023
Mitigate ischemia/reperfusion injury						
Ischemic post conditioning	RCT iPOST2 trial	1,800	STEMI with TIMI flow 0–1	Ischemic postconditioning with balloon (4 cycles 60s reperfusion/60s re-occlusion) without thrombectomy vs. standard PCI	All-cause mortality or HF hospitalization	January 2024
Coronary hypothermia	Non-RCT EURO ICE trial	200	Anterior STEMI with TIMI flow 0–1 Timing: 20 min before primary PCI	Selective intracoronary hypothermia during 20 min (10 min of occlusion phase and 10 min of reperfusion phase) followed by PCI vs. standard PCI	Infarct size 3 months after STEMI by CMR	January 2022
Left ventricle unloading	Pilot RCT STEMI DTU pivotal trial	668	Anterior STEMI Timing: 30 min before primary PCI	Impella CP® placement through femoral arterial sheath and activation during 30 min prior to primary PCI vs. standard PCI	Infarct size 3–5 days post-procedure by CMR	October 2027
Enabling microvascular response						
PICSO	Non-RCT PICSO AMI I trial	144	Anterior STEMI with TIMI flow 0–1 Timing: 45 min during primary PCI	Coronary sinus cannulation through femoral vein and PICSO placement, followed by stenting; then PICSO therapy during 45 min vs. standard PCI	Infarct size 5 days after STEMI by CMR	July 2025
SSO_2	RCT ISO SHOCK trial	60	STEMI with cardiogenic shock Timing: 60 min after primary PCI	PCI + Impella CP® + 60 min adjunctive reperfusion of SSO2 into culprit artery vs. PCI + Impella CP®	All-cause mortality at 30 days	June 2025

RCT, randomized clinical trial; CMR, cardiac magnetic resonance; HF, heart failure; HMI, high mechanical index; PICSO, pressure-controlled intermittent coronary sinus occlusion; PCI, percutaneous coronary intervention; SSO_2, supersaturated oxygen; STEMI, ST-segment-elevation myocardial infarction; TIMI, thrombolysis in myocardial infarction.

KSC 2022 DAILY

Arrhythmia

PV Isolation by RF

Sung-Hwan Kim, MD
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If you are not expert, try adenosine and exit test (intra LA, 20 mg), regardless of AV block. Wait over 20 minutes (to 90 min), and consider ablation order (Left ridge; try to achieve PVI without carina, and then add carina line) (**Figure 1**).

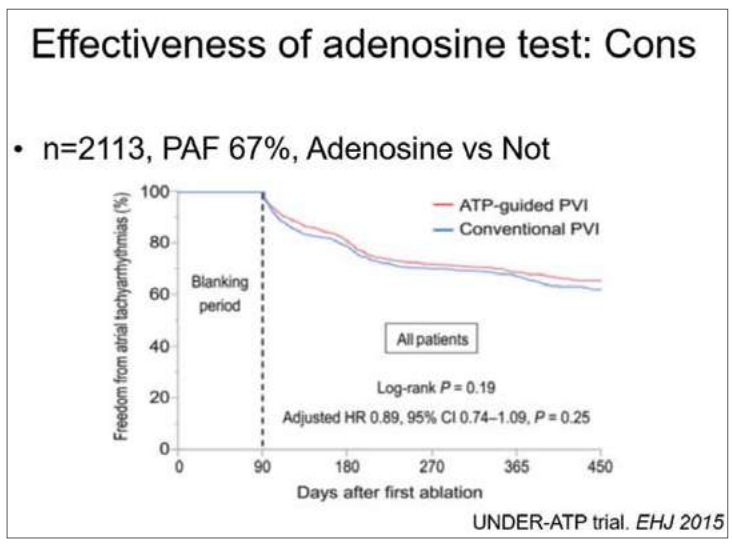

Figure 1. Effectiveness of adenosine test

Cryoballoon Ablation for AF

Hong Euy Lim, MD, PhD
Hallym University Medical Center, Korea

One method for treating atrial fibrillation (AF) is cryoablation using the cryoballoon catheter. Cryoballoon ablation (CBA) is a form of catheter ablation that uses cryo, or freezing energy, rather than heat to precisely disable unwanted electrical signals from the heart tissue, which contribute to AF.

The cryoballoon is a safe, effective, and efficient medical device for treating certain types of AF. This minimally invasive technique is especially effective in treating paroxysmal AF, in which AF symptoms occur intermittently. Nearly one million patients in over 80 countries worldwide have been treated with cryoablation devices because CBA is a safe and effective treatment before or after medication therapy to control AF. **CBA is not only a minimally invasive procedure with a short recovery time, but also can be simpler to perform than other ablation procedures because it does not require the use of complex, three-dimensional mapping systems.**

The equipment was designed specifically to help operators reach and treat tissue quickly and efficiently. The balloon design offers the ability to treat larger areas of the tissue at the same time, also simplifying the procedure. CBA is usually performed by an electrophysiologist who specializes in the treatment of irregular heart rhythms. The operator makes a small incision in the groin area to insert the catheter (small tube) to reach the heart. Then, the operator follows through the thin interatrial septal tissue that separates the left and right atria to reach the pulmonary veins with the cryoballoon. The operator inflates the balloon and moves it to the opening of the pulmonary vein. The goal is to maintain contact with the opening of the pulmonary vein (or called occlusion), so the balloon is able to reach a temperature that is cold enough. When the cryoballoon is in a good position, the operator freezes the tissue, creating a scar where the balloon touches the opening of the pulmonary vein. This line of scar tissue stops the transmission of electrical signals that cause AF. The procedure is relatively short and patients undergoing CBA may be less likely to need a repeat ablation or be re-hospitalized after AF ablation. Patients treated with the CBA may experience an improvement in their quality of life, as unpleasant symptoms such as shortness of breath, fatigue, and weakness lessen or disappear.

Arrhythmia 2
Advanced EP (Including Recorded Live Session)
›› Friday, Sep 23, 15:00-16:30, 324

How to Perform 3D Mapping for Atypical Atrial Flutter

Hyoung-Seob Park, MD
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The primary purpose of 3D activation mapping of the atypical atrial flutter (AFL) is to identify the reentrant circuit and its mid-diastolic critical isthmus. Initially, the reference electrogram is selected to compare the timing of sites sampled by the mapping catheter, the anatomical reference is positioned, and the window of interest is defined. Activation mapping (simultaneously with anatomical mapping) is performed to define the atrial activation sequence. Importantly, variation of the tachycardia cycle length (TCL) by more than 10% can potentially prevent a complete understanding of the circuit and limit the confidence in the map. The local activation time at each site is determined from the intracardiac bipolar electrogram and is measured in relation to the fixed intracardiac electrogram obtained from the coronary sinus catheter. Lines of a block (manifest as double or split atrial potentials) are tagged for easy identification because they can serve as boundaries for a subsequent ablation strategy design. In atrial macroreentry, the 3D electroanatomical activation map typically demonstrates a continuous progression of colors around a central obstacle with close proximity of earliest and latest local activation and an activation time in a range similar to the TCL. Zones of slow conduction, critical to the maintenance of the macroreentrant circuit, are usually identified by low-amplitude fractionated atrial electrograms. The earliest presystolic electrogram closest to mid-diastole is the most commonly used definition for the center of the isthmus of the reentrant circuit. Isthmuses within low voltage or scar areas commonly exhibit fragmented or continuous potentials with low voltage and long activation duration. When the onset of the window of interest is set at the mid-diastole between two consecutive P waves, the region where "early meets late" on the color-coded activation map can potentially correlate with the mid-diastolic isthmus of the reentrant circuit. The choice of ablation sites should be among those segments of the reentry circuit that offer the most convenient and safest opportunity for creating a conduction block. Ablation is performed by targeting the narrowest identifiable isthmus of conduction accessible within the circuit. The ablation line is chosen to transect an area critical for the circuit and to connect two anatomical areas of the block – an electrically silent area to an anatomical zone of block or two electrically silent areas. Voltage map can be used to guide the choice of the ablation site. The likelihood of achieving a complete and transmural ablation line is probably greater in low-voltage zones.

How to Perform Entrainment Pacing for Atypical Atrial Flutter

The definition of atypical atrial flutter includes a broad spectrum of macroreentrant tachycardias in which the wavefront does not follow the circuit of the typical atrial flutter. Atypical left atrial flutter includes the perimitral, peripulmonary veins, septal, and roof-dependent flutters.

Continued on page 9

Cardiac Surgery

Interventional Alternative for Calcific Mitral Stenosis and MAC

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The mitral valve (MV) annulus is a saddle-shaped fibrous structure, where mitral annular calcification (MAC) is common in the aging population and is linked to poor cardiovascular outcomes. Its prevalence is about 8% to 40% according to the study population, which the rate increases in the elderly population. MAC-related MV dysfunction denotes any abnormal hemodynamics in the mitral apparatus, and the prevalence is not clearly defined. For diagnosis, a comprehensive anatomical assessment should be performed using echocardiography and CT to measure the anatomic and hemodynamic significance. A previous study reported that patients with MAC-related MV dysfunction had a 10-year survival rate of 18%. The cause of poor outcomes can be explained by the MV dysfunction itself, elevated pulmonary artery pressure, and arrhythmia-related complications (i.e., atrial fibrillation or stroke).

In terms of hemodynamics, MAC may extend directly into the leaflets, resulting in restricted leaflet motion and impaired coaptation. MAC can distort valvular geometry, leading to leaflet restriction and coaptation impairment. Additionally, the mitral annulus usually changes the morphology in conjunction with the left ventricular (LV) systolic contraction. However, MAC that extends into the basal LV myocardium can impair this process. This complex process can lead to mitral regurgitation, mitral stenosis, or a mixed pattern.

The treatment of MAC-related MV dysfunction remains medical management with heart failure management, while valvular interventions to directly address the valvular dysfunction should be performed in selected patients. Transcatheter therapies for patients with MAC-related MV dysfunction is a rapidly developing field. Currently, in patients with MAC and severe regurgitation, percutaneous edge-to-edge repair or mitral valve repair can be performed on the basis of appropriate patient selection. In patients with MAC and mitral stenosis, percutaneous mitral TAVI valves can be implanted in the MV, with MAC serving as an anchor. However, due to the original elliptical morphology, the major limitation of this approach is left ventricular outflow tract (LVOT) obstruction from the ventricular edge of the implanted valve overhanging into the LVOT. Major advances have been made to overcome various concerns, including technical improvements using current devices and the development of newer generation valves.

In the future, more sophisticated diagnostic tests should be performed to better define which patients are likely to benefit from valvular interventions. Also, additional research should focus on early detection of MAC-related MV dysfunction earlier in the disease course and prevention of disease progression. Until then, MAC-related MV dysfunction will remain a challenging disease.

Cardiac Surgery
Diagnosis and Management of Calcific Mitral Stenosis and Mitral Annular Calcification
›› Friday, Sep 23, 10:40-12:10, 321

Cross Specialty 3: CTEPH

Irene Lang, MD
Medical University of Vienna, Austria

Evolution of CTEPH Treatment: Pulmonary Vasodilator Therapy

Chronic thromboembolic pulmonary hypertension (CTEPH) is characterized by fibro-thrombotic material mechanically obliterating major pulmonary arteries, resulting in increased pulmonary vascular resistance (PVR), progressive pulmonary hypertension (PH) combined with a microscopic pulmonary vasculopathy, right ventricular (RV) failure and premature death. Survival in the eighties was dismal, while data from an international registry between 2007 and 2009 reported survival rates of 92, 75, and 60% at 1, 3, and 5 years, respectively. Data from a most recent European registry from 2015 and 2016 suggest even better survival. Surgical pulmonary endarterectomy (PEA) and balloon pulmonary angioplasty (BPA), in combination with vasodilator drugs have markedly improved outcomes in CTEPH. My talk will focus on **the role of medical vasodilator treatments in combination with PEA and BPA.**

Cross Specialty 3: CTEPH
Chronic Thromboembolic Pulmonary Disease - Recent Advances with Paradigm Shift
›› Friday, Sep 23, 13:20-14:50, 324

Jung Myung Lee, MD, PhD
Kyunghee University Hospital, Korea

Continued from page 8

Entrainment is an important pacing maneuver that can be used to identify reentry as a tachycardia mechanism and define components of the circuit. Entrainment is the continual or repeated resetting of a reentrant tachycardia by each of a series of consecutive beats of a pacing train. The criteria for entrainment are: 1) constant fusion during overdrive pacing except for the last paced beat which is entrained but not fused, 2) progressive fusion during overdrive pacing, 3) localized conduction block to a site for 1 paced beat associated with interruption of the tachycardia, followed by activation of that site by the next paced beat from a different direction and with a shorter conduction time, 4) there is change in conduction time and EGM morphology at the electrode recording site during pacing at 2 different rates during tachycardia (this is actually the equivalent of demonstrating progressive fusion with EGM; the second criteria).

Limitations in using concealed entrainment must be recognized: 1) rate-related conduction slowing; 2) failure to capture; 3) acceleration or termination of atrial tachycardia with pacing; 4) spontaneous variations in the tachycardia cycle length.

Entrainment mapping may be combined with electroanatomic mapping to define critical components of a reentrant circuit. This combined technique is especially useful in situations in which the electroanatomic map is ambiguous, and it is difficult to distinguish critical components from bystander regions.

Arrhythmia 3
Catheter Ablation for Atrial Flutter
›› Friday, Sep 23, 16:40-18:10, 324

KSC 2022 DAILY

Intervention

Recorded Live: Retrial of Failed CTO Intervention Case

윤창환 교수
분당서울대학교병원

Chronic total occlusion (CTO) intervention은 다른 관상동맥중재시술에 비해 실패할 가능성이 높다. 길이 보이지 않는 관상동맥 폐쇄구간을 맹인이 지팡이로 길을 더듬어 걸어가듯 와이어를 조심스럽게 진행해 가면서 원위부 혈관내강으로 진입해야 하기 때문에 시술자의 손에 느껴지는 감각과 2차원으로 보이는 혈관조영술 영상을 3차원으로 전환시켜 길을 예측하는 경험과 기술이 필요하다. 지나가는 병변이 길거나 막힌 지 오래되었거나, 석회화가 심한 경우 등 실패확률을 증가시키는 여러가지 요소가 있다. 하지만 일정기간을 두고 시술을 다시 시도하면 성공확률을 올릴 수 있다. **이번 Recorded Live를 통해 첫 번째 시술 때 실패한 CTO intervention case의 재시도를 통해 어떻게 성공했는지 녹화 영상을 통해 보여드리고, 성공적인 CTO intervention을 위한 많은 노하우를 CTO 전문가분들로부터 들어볼 수 있는 기회를 드리고자 한다.**

해당 case는 62세 남성 환자로, 뇌동맥 협착 및 폐쇄에 대한 평가를 위해 신경과 입원 중 관상동맥 평가를 하고자 시행한 CT 혈관조영술에서 우관상동맥 폐색이 발견되었다. 고혈압과 고지혈증이 있어 투약 중이었고, 심혈관계 증상은 호소하지 않고 있었으나 심장하벽부의 국소벽운동장애가 동반되어 있어 유의한 심근허혈이 있을 것으로 판단하고 심혈관조영술 및 관상동맥중재술을 계획하였다.

Figure 1에서와 같이 우관상동맥 근위부 및 원위부 각각 떨어져 완전폐색이 있었고, PDA (posterior descending artery) 및 PL (posterolateral) branch는 collateral flow를 통해 관찰되었다. 1차 시도에서 Antegrade wiring을 통해 시술을 시도하였으나 실패하였다. 이후 2차 시도에서 어떤 우여곡절을 통해 **Figure 2**와 같이 성공적인 시술을 하게 되었는지 현장에서 확인해 주시기를 바란다.

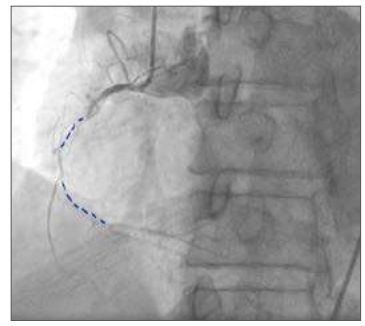

Figure 1. 우관상동맥조영술: 근위부 및 원위부의 완전폐색(파란색 점선) 관찰

Figure 2. 2차 시도에서 개통에 성공한 후 우관상동맥조영술

Intervention 1
CTO Recorded Live Session
›› Friday, Sep 23, 09:00-10:30, 325CD

Basic Research

Magnetically Controlled Microrobots for CTO Intervention

Hongsoo Choi, PhD
DGIST, Korea

Robotic magnetic systems may enable precise and fast control of the interventional tools (e.g., guidewires and catheters) in tortuous vessels. Physicians can also avoid ionizing the X-ray radiation from fluoroscopy. Recently, a robotic magnetic interventional system - Electromagnetically Controllable Microrobotic Interventional System (ECMIS) - was developed at Daegu Gyeongbuk Institute of Science and Technology (DGIST) for remote manipulation and active steering of guidewires in the treatment of cardiovascular diseases. The ECMIS consists of a microrobotic guidewire in which a soft magnetically steerable robot (MSR) is attached to the tip of a guidewire, a human-scale electromagnetic control system, a biplane X-ray imaging unit, and a master-slave system (**Figure 1A**). The flexible magnetic MSR at the tip of the guidewire exploits magnetic torques for active guidewire steering upon magnetic actuation. By adjusting the input of electric currents to the electromagnetic control system, the strength and direction of the magnetic fields can be instantly changed, allowing the microrobotic guidewire to quickly steer toward the desired directions. The guidewire can be advanced and retracted by the master-slave system in a teleoperated manner. The potential clinical effectiveness of ECMIS for cardiovascular interventions was demonstrated through preclinical evaluation in various arteries of swine models (**Figure 1B**).

ECMIS uses magnetic fields that are significantly weaker (10–20 mT) than those of clinical magnetic resonance scanners (~3 T) and other legally marketed magnetic control systems; thus, the magnetic fields exploited by ECMIS may not be a concern when it comes to safety issues. Ultimately, the system will obtain market clearance and approval after further preclinical and clinical studies.

Basic Research 1
Innovative Biomedical Engineering Research for Cardiovascular Disease
›› Friday, Sep 23, 15:00-16:30, 321

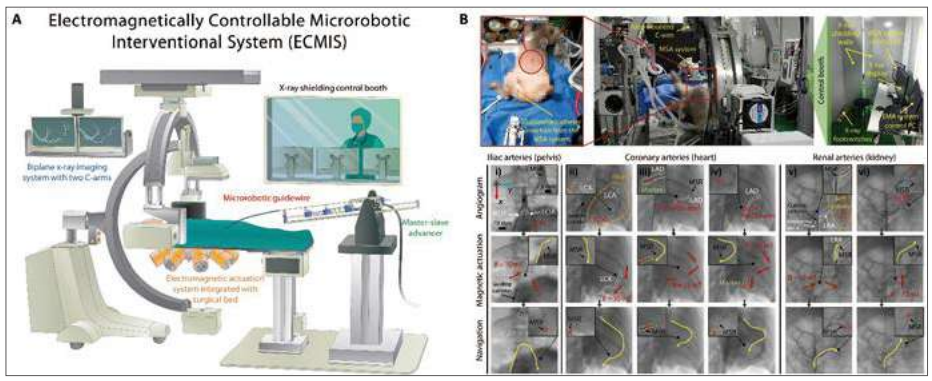

Figure 1. (A) Schematic diagram of the conceptual overview of ECMIS. **(B)** Preclinical evaluation of ECMIS for targeted vascular interventions *in vivo* (Adv Healthc Mater 2022;11:e2102529)

Cardiac Pathology

Historical Review and Future of Cardiac Xenograft

Ji Won Koh, MD
Seoul National University Hospital, Korea

On January 7th, 2022, a historical event of pig-to-human cardiac xenotransplantation was performed using genetically engineered porcine xenograft and co-stimulation blockade-based immunosuppression (**Figure 1**). Though the patient developed xenograft failure and succumbed to death on post-operative day 60, this event shed light on the cumulative efforts of scientists and physicians who worked hard to unveil the underlying immunobiology of cross-species organ transplantation.

Along with the development of immunosuppressive drugs, major advances on xenotransplantation were achieved by understanding the immunobiology of xenograft rejection. Most importantly, three predominant carbohydrate antigens on porcine endothelial cells were key elements provoking hyperacute rejection: α1,3-galactose (Gal), SDa blood group antigen and N-glycolylneuraminic acid (Neu5Gc). Preformed antibodies binding to the major porcine xenoantigen causes complement activation and endothelial cell activation, leading to xenograft injury and intravascular thrombosis. Recent advances in genetic engineering enabled knock-outs of these major xenoantigens, thus producing so-called 'triple knockout pigs,' which showed less hyperacute rejection rates.

Another milestone of the history of xenotransplantation was the development of co-stimulation blockaded strategy. Unlike allotransplantation, xenotransplantation requires blockade of CD40-CD40L pathway to prevent T-cell dependent B-cell activation and antibody production. Using monoclonal antibodies to block this pathway resulted in the rejection-free survival of up to 945 days in a pig-to-primate xenotransplantation.

In the 2010s, advanced genetic engineering of xenograft by inducing the expression of multiple human transgenes became available. So-called 'multi-gene' xenografts expressing human transgenes such as thrombomodulin and endothelial protein C receptor were introduced, which resulted in the reduction of thrombotic events and improvement of xenograft survival.

Continued on page 10

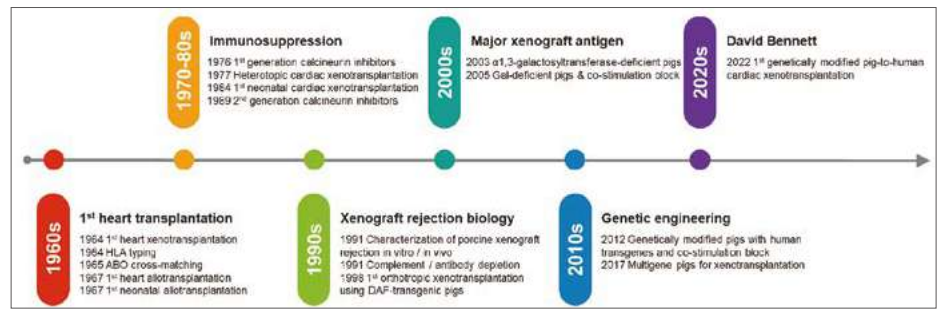

Figure 1. Historical milestones of cardiac allograft and xenograft

Cross Specialty 4: Intervention & Heart Failure & Cardiac Surgery

Optimization of GDMT in Heart Failure

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Clinical practice guidelines emphasize the need for guideline-directed medical therapy (GDMT) in patients with heart failure with reduced ejection fraction (HFrEF) (**Figure 1**). Given the high risk of adverse outcomes in patients with HFrEF, there is an urgent need for the initiation and titration of GDMT that can reduce the risk of morbidity and mortality. Clinical practice guidelines are also emphasizing the need for early and rapid initiation of therapies that have cardiovascular benefits. Recognizing that there are many barriers to GDMT initiation and optimization, **healthcare providers should aim to introduce the 4 pillars of quadruple therapy now recommended by most clinical practice guidelines: angiotensin receptor–neprilysin inhibitors, beta-blockers, mineralocorticoid receptor antagonists, and sodium–glucose co-transporter 2 inhibitors.** A large proportion of patients with HFrEF do not have clinical contraindications to GDMT but are not treated with these therapies. Early initiation of low-dose combination therapy should be tolerated by most patients. However, patient-related factors such as hemodynamics, frailty, and laboratory values will need to be considered for maximum tolerated GDMT. The GDMT initiation in acute heart failure hospitalization represents another important avenue to improve use of GDMT. Finally, removal of therapies that do not have clear cardiovascular benefits should be considered to lower polypharmacy and reduce the risk of adverse side effects. Future prospective studies aimed at guiding optimal implementation of quadruple therapy are warranted to reduce morbidity and mortality in patients with HFrEF.

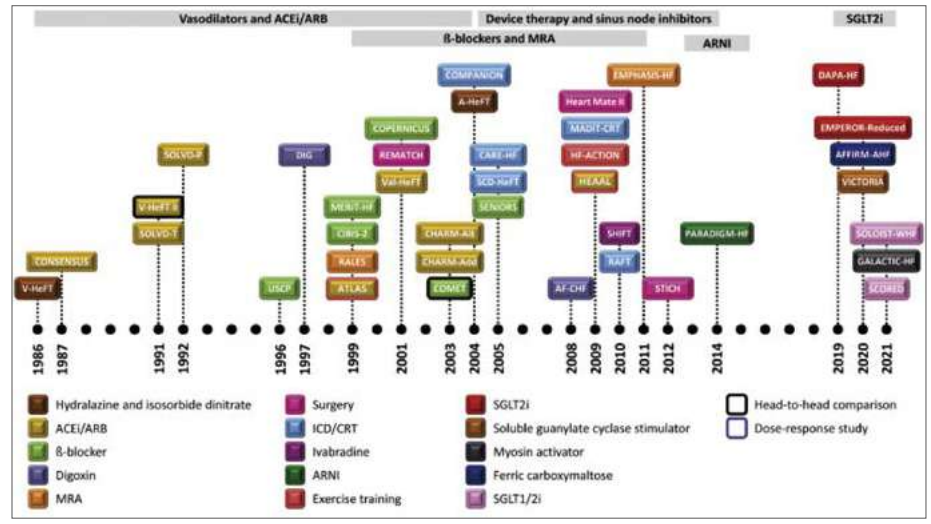

Figure 1. Summary of advances in medical therapies in patients with HF and reduced ejection fraction (JACC Basic Transl Sci 2022;7:504-517)

Continued from page 11

Still, there are many limitations to clinical translation of cardiac xenotransplantation. Along with technical challenges, zoonotic infection and physiological discordances are major obstacles. Social barriers including healthcare costs also need to be addressed. **Although there are several remaining obstacles to overcome, xenotransplantation would surely become a novel option for millions of patients with end-stage heart failure who have limited options to traditional therapeutics.**

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