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CARDIOLOGY

Examination Paper

for DM (Cardiology) Students



Barun Kumar

Foreword
Gurpreet S Wander

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DM CARDIOLOGY EXAMINATION

Paper 3 (Set 1)

LONG-ESSAY QUESTIONS AND ANSWERS

Q 1. Discuss approach to diagnosis and management of 'Broad complex tachycardia'. ***(Refer 2019 MUHS)***

Ans. Broad complex tachycardia (BCT) is characterized by a rapid heart rate with a widened QRS complex on an electrocardiogram (ECG), typically greater than 120 milliseconds. It is crucial to differentiate between ventricular tachycardia (VT) and supraventricular tachycardia (SVT) with aberrancy because their management differs significantly.

Diagnostic Approach

- *History taking:* Gather information on symptoms, duration of tachycardia episodes, associated symptoms (e.g., chest pain, palpitations), and any history of heart disease or medications.
- *Physical examination:* Assess vital signs, cardiac auscultation for murmurs or gallops, and signs of hemodynamic instability (e.g., hypotension, altered mental status).
- *Electrocardiogram interpretation:*
  - *QRS morphology:* Analyze the QRS complex for characteristics suggestive of VT (bizarre, wide, monomorphic) or SVT with aberrancy (often regular, varying QRS morphology)
  - *Additional ECG criteria:* Look for features like atrioventricular (AV) dissociation, capture or fusion beats, and presence of concordance (all leads showing positive or negative QRS complexes)
- *Differential diagnosis:* Consider other causes of wide complex tachycardia such as bundle branch block, electrolyte abnormalities, or drug toxicity.

Management Strategies

- *Immediate management in acute settings:*
  - *Stable patient:* Assess hemodynamic stability and consider vagal maneuvers or adenosine for suspected SVT with aberrancy
  - *Unstable patient:* Immediate synchronized cardioversion is warranted regardless of the tachycardia type.
- *Pharmacological interventions:*
  - *Ventricular tachycardia:* Antiarrhythmic medications like amiodarone, lidocaine, or procainamide may be used.

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  - *Supraventricular tachycardia with aberrancy:* Avoid AV nodal blocking agents (e.g., adenosine, beta-blockers) and consider procainamide or amiodarone under expert supervision.
- *Cardioversion techniques: Synchronized cardioversion:* Delivery of a synchronized shock during the QRS complex to terminate unstable VT or SVT with aberrancy.
- *Long-term management considerations:* Address underlying causes such as ischemic heart disease, electrolyte disturbances, or structural heart disease to prevent recurrent episodes
  - Consider electrophysiological studies for patients at risk of recurrent or refractory tachycardia.
- *Role of electrophysiological studies:* Reserved for cases requiring definitive diagnosis or assessment of arrhythmia mechanisms, especially if noninvasive measures are inconclusive or inadequate.

Special Considerations

- *Specific etiologies:* Tailor management based on underlying conditions such as myocardial infarction (MI), cardiomyopathy, or congenital heart disease.
- *Patient population:* Consider age-related differences in presentation and management approaches, especially in pediatric or elderly patients.

Broad complex tachycardia requires a systematic approach for accurate diagnosis and prompt intervention to optimize patient outcomes. Collaborative efforts among cardiologists, emergency physicians, and electrophysiologists are essential for effective management and long-term care.

This comprehensive approach underscores the importance of differential diagnosis, acute management strategies, and long-term considerations in the treatment of BCT.

Q 2. Discuss etiology, pathogenesis, clinical features, and management of heart failure with preserved ejection fraction (HFpEF).
(Refer 2019 MUHS)

Ans.

Heart Failure with Preserved Ejection Fraction

Heart failure with preserved ejection fraction presents a unique challenge in cardiovascular medicine, characterized by heart failure symptoms despite preserved systolic function. Here is a comprehensive overview covering its etiology, pathogenesis, clinical features, and management.

Etiology

HFpEF typically results from a combination of cardiovascular and non-cardiovascular factors:

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- *Cardiovascular factors:*
  - *Hypertension:* Chronic elevation in blood pressure leads to left ventricular hypertrophy and diastolic dysfunction.
  - *Coronary artery disease (CAD):* Ischemic heart disease can impair diastolic relaxation and compliance.
  - *Atrial fibrillation (AF):* A common comorbidity contributing to diastolic dysfunction and impaired ventricular filling.
  - *Valvular heart disease:* Particularly aortic stenosis or regurgitation can lead to increased left ventricular pressures and subsequent diastolic dysfunction.
- *Noncardiovascular factors:*
  - *Age:* Increased myocardial stiffness and decreased compliance are more prevalent with aging.
  - *Obesity:* Adipose tissue-derived inflammatory cytokines can contribute to systemic inflammation and cardiac fibrosis.
  - *Diabetes mellitus:* Insulin resistance and hyperglycemia can promote myocardial fibrosis and diastolic dysfunction.
  - *Chronic kidney disease:* Fluid retention and electrolyte disturbances exacerbate cardiac workload.

Pathogenesis

The pathophysiology of HFpEF involves:

- *Diastolic dysfunction:* Impaired ventricular relaxation and increased stiffness impair ventricular filling during diastole.
- *Increased ventricular stiffness:* Myocardial fibrosis and collagen deposition lead to reduced compliance.
- *Neurohormonal activation:* Similar to HF with reduced ejection fraction (HFrEF), activation of the renin–angiotensin–aldosterone system and sympathetic nervous system contributes to disease progression.
- *Endothelial dysfunction:* Impaired nitric oxide signaling, and vascular reactivity exacerbate myocardial stiffness and systemic congestion.

Clinical Features

- *Symptoms:* Patients present with exertional dyspnea, fatigue, and fluid retention (e.g., peripheral edema, ascites).
- *Physical examination:* Signs include elevated jugular venous pressure, pulmonary crackles, and peripheral edema.
- *Diagnostic tests:* Echocardiography confirms preserved ejection fraction (>50%) with evidence of diastolic dysfunction (e.g., elevated E/e′ ratio, impaired relaxation).
- *Biomarkers:* B-type natriuretic peptide (BNP) and N-terminal pro-BNP (NT-proBNP) levels may be elevated, reflecting ventricular stress and dysfunction.

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Management

Management of HFpEF focuses on symptom relief, optimizing quality of life, and addressing underlying comorbidities:

- *Pharmacological therapy:*
  - *Diuretics:* Manage fluid overload and congestion
  - *Angiotensin-converting enzyme (ACE) inhibitors/angiotensin receptor blockers (ARBs):* Improve symptoms and potentially reduce hospitalizations in selected patients.
  - *Beta-blockers:* Control heart rate and may improve exercise tolerance
  - *Mineralocorticoid receptor antagonists (MRAs):* Considered in patients with persistent symptoms despite standard therapy.
  - *Other agents:* Limited evidence supports the use of medications such as ivabradine, particularly in controlling heart rate.
- *Non-pharmacological approaches:*
  - *Lifestyle modifications:* Weight reduction, sodium restriction, and regular exercise to improve cardiovascular fitness
  - *Comorbidity management:* Optimize treatment of hypertension, diabetes, and AF
  - *Device therapy:* Limited role; cardiac resynchronization therapy (CRT) may benefit selected patients with conduction abnormalities and symptoms refractory to medical therapy.
  - *Surgical interventions:* Mitral valve repair or replacement for significant regurgitation contributing to symptoms
- *Patient education and follow-up:*
  - Emphasize medication adherence, symptom monitoring, and early recognition of worsening symptoms
  - Regular follow-up visits to assess clinical status, adjust therapy as needed, and monitor for complications

HFpEF represents a complex syndrome with multifaceted etiology, pathogenesis, and clinical manifestations. Effective management requires a tailored approach addressing underlying cardiovascular and non-cardiovascular contributors, optimizing symptom control, and improving overall patient outcomes through comprehensive care strategies.

SHORT QUESTIONS AND ANSWERS

Q 1. Rivaroxaban. ***(Refer 2019 MUHS)***

Ans. Rivaroxaban is a medication that belongs to the class of direct oral anticoagulants (DOACs), specifically targeting factor Xa in the coagulation cascade. Here is a detailed discussion covering its uses, mechanism of action, clinical indications, and considerations:

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Mechanism of Action

Rivaroxaban inhibits factor Xa, a key enzyme in the coagulation cascade responsible for the conversion of prothrombin to thrombin. By blocking factor Xa, rivaroxaban interferes with the generation of thrombin and subsequent formation of fibrin clots, thereby exerting anticoagulant effects.

Clinical Indications

- *Prevention and treatment of venous thromboembolism (VTE):*
  - *Deep vein thrombosis (DVT):* Rivaroxaban is used for the treatment and prevention of recurrent DVT and pulmonary embolism (PE).
  - *Pulmonary embolism:* It is also indicated for the treatment and prevention of PE.
  - *Extended thromboprophylaxis:* In some cases, it may be used for extended thromboprophylaxis in high-risk situations such as after orthopedic surgery.
- *Stroke prevention in AF:* Rivaroxaban is approved for stroke prevention in patients with non-valvular atrial fibrillation, offering an alternative to warfarin.
- *Acute coronary syndrome (ACS):* In combination with antiplatelet therapy, rivaroxaban may be used for secondary prevention in patients with ACS.

Pharmacokinetics

- *Absorption:* Rivaroxaban is well absorbed orally, with peak plasma concentrations achieved within 2–4 hours.
- *Metabolism:* It undergoes hepatic metabolism primarily via cytochrome P450 enzymes (CYP3A4 and CYP2J2).
- *Elimination:* The drug is eliminated via renal (66%) and hepatic (28%) routes, with a half-life of approximately 5–9 hours in healthy individuals.

Monitoring and Reversal

- *Monitoring:* Unlike warfarin, rivaroxaban does not require routine monitoring of international normalized ratio (INR). However, monitoring renal function is important due to its renal clearance.
- *Reversal agent:* Andexanet-alfa is a specific reversal agent for rivaroxaban and other factor Xa inhibitors in case of life-threatening bleeding or urgent surgery.

Adverse Effects

- *Bleeding:* As with all anticoagulants, rivaroxaban increases the risk of bleeding, including gastrointestinal bleeding and intracranial hemorrhage.
- *Renal function:* Due to renal excretion, dose adjustments are necessary in patients with impaired renal function to prevent accumulation and bleeding risk.

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Considerations

- *Drug interactions:* Rivaroxaban interacts with medications that affect CYP3A4 and P-glycoprotein (P-gp) pathways, potentially altering its efficacy and safety profile.
- *Patient counseling:* Patients should be educated on signs of bleeding, adherence to prescribed dosing, and the importance of regular follow-up visits.

Rivaroxaban represents a significant advancement in anticoagulant therapy, offering convenient oral dosing, predictable pharmacokinetics, and a broad spectrum of clinical indications from VTE treatment to stroke prevention in atrial fibrillation. However, careful patient selection, monitoring, and adherence to dosing guidelines are crucial to optimize its safety and efficacy in clinical practice.

Q 2. Cardiac biomarkers. ***(Refer 2019 MUHS)***

Ans. Cardiac biomarkers play a crucial role in diagnosing and managing various cardiac conditions. Here is an overview covering their types, clinical significance, and applications in cardiovascular medicine:

Types of Cardiac Biomarkers

1. *Troponins:*
   - *Types:* Troponin I (cTnI) and Troponin T (cTnT)
   - *Clinical use:* Highly sensitive and specific for myocardial injury, particularly in acute coronary syndrome
2. *B-type natriuretic peptide and N-terminal pro-BNP:*
   - *Clinical use:* Indicators of myocardial stress and heart failure (HF), aiding in diagnosis, prognosis, and guiding therapy
3. *Creatine kinase-MB (CK-MB):*
   - *Clinical use:* Formerly used in diagnosing MI; now less commonly used compared to troponins.
4. *Myoglobin:*
   - *Clinical use:* Early marker of myocardial injury, less specific than troponins.
5. *C-reactive protein (CRP):*
   - *Clinical use:* Marker of inflammation associated with atherosclerosis and cardiovascular risk

Clinical Significance

- *Diagnosis:*
  - *Acute coronary syndrome:* Troponins are critical for diagnosing MI.
  - *Heart failure:* BNP and NT-proBNP help in differentiating between cardiac and noncardiac causes of dyspnea.

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- *Prognosis:*
  - Elevated troponin levels indicate a worse prognosis in ACS and other cardiac conditions.
  - Higher BNP/NT-proBNP levels correlate with increased mortality and HF severity.
- *Management:*
  - Biomarkers guide treatment strategies, such as initiating antiplatelet therapy in ACS or adjusting diuretics in HF based on BNP/NT-proBNP levels.
  - Serial biomarker measurements monitor response to therapy and predict clinical outcomes.

Applications in Cardiovascular Medicine

- *Risk stratification:* Biomarkers aid in assessing cardiovascular risk and guiding preventive strategies.
- *Monitoring:* Serial measurements track disease progression, response to treatment, and identify complications.
- *Emergency settings:* Rapid biomarker testing facilitates timely diagnosis and intervention in acute cardiac emergencies.

Cardiac biomarkers serve as indispensable tools in cardiovascular medicine, providing critical insights into diagnosis, prognosis, and management strategies across a spectrum of cardiac conditions. Their role extends beyond acute settings to guiding long-term care and improving patient outcomes through targeted therapeutic interventions and vigilant monitoring.

Q 3. PARADIGM-HF trial. ***(Refer 2019 MUHS)***

Ans. The PARADIGM-HF trial, a landmark study in heart failure management, evaluated the efficacy and safety of Sacubitril/Valsartan (Entresto) compared to enalapril in patients with HFrEF. Here is an overview covering its significance, key findings, and implications:

Significance

The PARADIGM-HF trial addressed the need for novel therapeutic options beyond ACE inhibitors and ARBs in treating HFrEF. It aimed to assess whether Sacubitril/Valsartan, a neprilysin inhibitor combined with an ARB, could provide superior outcomes compared to traditional ACE inhibitor therapy.

Key Findings

- *Primary endpoints:* Sacubitril/Valsartan significantly reduced the risk of cardiovascular death or hospitalization for heart failure compared to enalapril (hazard ratio 0.80, $p < 0.001$).

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- *Secondary endpoints:* Improved symptoms, reduced NT-proBNP levels, and better quality of life measures were observed in the Sacubitril/Valsartan group.
- *Safety:* Generally well-tolerated, with adverse events comparable to enalapril, except for higher rates of hypotension and non-serious angioedema.

Implications

- *Clinical practice:* Sacubitril/Valsartan has become a cornerstone therapy in HFrEF management, recommended in guidelines as a first-line treatment option.
- *Outcome improvement:* Offers significant mortality and morbidity benefits, prompting a shift in treatment paradigms for HFrEF patients.
- *Future research:* Stimulated interest in neprilysin inhibition and its potential applications in other cardiovascular conditions.

The PARADIGM-HF trial revolutionized HFrEF management by demonstrating the superiority of Sacubitril/Valsartan over traditional ACE inhibitor therapy, reshaping treatment guidelines and improving patient outcomes through its innovative mechanism of action. Its findings underscore the importance of continuing research into novel therapeutic strategies to advance HF care.

Q 4. Alcohol septal ablation in HOCM. ***(Refer 2019 MUHS)***

Ans. Alcohol septal ablation (ASA) is a catheter-based procedure used to treat symptomatic hypertrophic obstructive cardiomyopathy (HOCM), a genetic cardiac condition characterized by abnormal thickening of the heart muscle, particularly the septum. Here is a detailed discussion on its procedure, efficacy, indications, and considerations:

Procedure

- *Technique:* Under fluoroscopic guidance, a catheter is advanced into the septal artery supplying the hypertrophied myocardium.
- *Alcohol infusion:* A small amount of absolute alcohol is injected into the target septal artery, causing localized myocardial necrosis.
- *Septal reduction:* The induced necrosis reduces septal thickness and alleviates left ventricular outflow tract (LVOT) obstruction.

Efficacy

- *Symptom relief:* Effective in relieving symptoms such as dyspnea, chest pain, and exercise intolerance in symptomatic HOCM patients
- *Hemodynamic improvement:* Reduces LVOT gradient, improving cardiac output and exercise tolerance
- *Long-term outcomes:* Comparable efficacy to surgical myectomy in selected patients, with sustained symptom relief and improvement in quality of life.

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Indications

- *Symptomatic HOCM:* Recommended for patients with severe symptoms refractory to optimal medical therapy
- *LVOT obstruction:* Significant LVOT gradient (>50 mm Hg at rest or with provocation) despite medical treatment
- *Patient selection:* Careful patient selection is crucial, assessing for appropriate anatomy, symptom severity, and potential procedural risks.

Considerations

- *Complications:* Potential risks include complete heart block necessitating permanent pacemaker insertion, arrhythmias, coronary artery injury, and ventricular septal defect.
- *Long-term monitoring:* Regular follow-up to monitor for recurrence of symptoms, LVOT gradient, and complications.
- *Alternative therapies:* Surgical myectomy remains the gold standard for symptomatic relief in HOCM, especially in younger patients or those with complex anatomy.

Alcohol septal ablation represents a valuable therapeutic option in the management of symptomatic HOCM, offering significant symptom relief and hemodynamic improvement in appropriately selected patients. Despite its effectiveness, careful patient selection, procedural expertise, and long-term monitoring are essential to optimize outcomes and minimize risks associated with this interventional approach.

Q 5. PTCA in CTO. ***(Refer 2019/2013 MUHS)***

Ans. Percutaneous transluminal coronary angioplasty (PTCA) is a procedure commonly used to treat chronic total occlusions (CTO) in coronary arteries. Here is a detailed discussion covering its procedure, efficacy, indications, and considerations:

Procedure

- *Technique:* PTCA for CTO involves advancing a guidewire across the occluded segment of the coronary artery using specialized equipment and techniques.
- *Balloon angioplasty:* Once the guidewire crosses the occlusion, a balloon catheter is positioned and inflated at the site of the CTO to compress the plaque and open the artery.
- *Stenting:* In many cases, a stent is placed after successful balloon angioplasty to maintain patency of the artery and prevent restenosis.

Efficacy

- *Symptom relief:* PTCA in CTO aims to alleviate symptoms such as angina and improve exercise tolerance.

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- *Improvement in blood flow:* Successful revascularization restores blood flow through the previously occluded artery, enhancing myocardial perfusion.
- *Clinical outcomes:* Improves quality of life and reduces the need for repeat hospitalizations due to angina or other cardiac symptoms.

Indications

- *Symptomatic patients:* Recommended for patients with angina or other symptoms related to CTO that are not adequately controlled with medical therapy.
- *Ischemia:* Presence of documented myocardial ischemia due to the CTO, as assessed by functional testing or imaging.
- *Suitable anatomy:* Anatomical factors such as vessel size, location of CTO, and collateral circulation influence the feasibility and success of PTCA.

Considerations

- *Technical challenges:* CTO procedures are technically demanding and require specialized skills and equipment, often performed by experienced interventional cardiologists.
- *Complications:* Risks include vessel perforation, dissection, distal embolization, and contrast-induced nephropathy.
- *Alternative therapies:* In cases where PTCA is not feasible or unsuccessful, coronary artery bypass grafting (CABG) may be considered for revascularization.

Percutaneous transluminal coronary angioplasty is a valuable intervention for CTO, offering symptomatic relief and improving myocardial perfusion in appropriately selected patients. Despite its effectiveness, the procedure requires careful patient selection, procedural expertise, and consideration of potential risks and alternative treatment options to achieve optimal outcomes in managing CTOs.

Q 6. Fractional flow reserve. ***(Refer 2019 MUHS, 2021/2015 MGR)***

Ans. Fractional flow reserve (FFR) is a physiological index used in interventional cardiology to assess the severity of coronary artery stenosis and guide treatment decisions. Here is an overview covering its principle, clinical applications, procedural aspects, and implications:

Principle

- *Definition:* FFR quantitatively measures the maximum achievable blood flow in a coronary artery with a stenosis compared to maximum blood flow if the arteries were normal.

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- *Measurement:* It is calculated as the ratio of distal coronary pressure (in the stenotic artery) to aortic pressure during maximum hyperemia induced pharmacologically.

Clinical Applications

- *Assessment of stenosis severity:* Helps determine whether a coronary lesion causing ischemia warrants intervention (PCI or CABG) or can be managed conservatively.
- *Guiding treatment decisions:* FFR values ≤0.80 indicate ischemia-producing stenosis, guiding revascularization decisions to optimize patient outcomes.
- *Multi-vessel disease:* Useful in assessing and prioritizing lesions in patients with multi-vessel coronary artery disease.

Procedural Aspects

- *Procedure:* FFR is measured using a pressure wire or sensor placed distal to the coronary stenosis during maximal hyperemia-induced pharmacologically (e.g., with adenosine).
- *Measurement interpretation:* A lower FFR value (≤0.80) indicates significant stenosis, while a higher value (>0.80) suggests less hemodynamically significant disease.
- *Benefits:* Provides objective physiological data to complement angiographic findings, aiding in treatment decisions and potentially reducing unnecessary revascularizations.

Implications

- *Clinical outcomes:* FFR-guided PCI has been associated with improved clinical outcomes, including reduced rates of major adverse cardiovascular events (MACE) compared to angiography-guided PCI alone.
- *Cost-effectiveness:* Helps optimize healthcare resource utilization by targeting interventions to lesions that truly benefit from revascularization.
- *Educational value:* Advances understanding of coronary physiology and enhances procedural skills in interventional cardiology.

Fractional flow reserve is a pivotal tool in interventional cardiology, providing precise physiological assessment of coronary artery stenosis severity to guide optimal treatment strategies. By integrating objective FFR measurements with angiographic findings, clinicians can tailor revascularization decisions, improve patient outcomes, and promote cost-effective use of healthcare resources in managing coronary artery disease.

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Barun Kumar MD DM (Cardiology) is an Additional Professor and Interventional Cardiologist, Department of Cardiology, All India Institute of Medical Sciences (AIIMS), Rishikesh, Uttarakhand, India. He is recognized for his role in the establishment of the Department of Cardiology at AIIMS, Rishikesh. He completed DM (Cardiology) from Dr Ram Manohar Lohia Hospital, New Delhi, India. He has been engaged in many teaching endeavors over the past 11 years. For the past 6 years, he has been instructing and educating students in the field of DM Cardiology. He has more than 85 national and international publications including book chapters. He has a particular inclination for teaching. He possesses extensive knowledge and experience in the domain of interventional cardiology.

Printed in India

Available at all medical bookstores or buy online at www.ejaypee.com

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Medical Publishers (P) Ltd.
EMCA House, 23/23-B, Ansari Road,
Daryaganj, New Delhi - 110 002, INDIA
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ISBN 978-93-6616-755-8