Anesthesia for Patients in the Cardiac Catheterization Laboratory

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Conference Rooms E & F

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- No Disclosures

Topics

- Lab Environment
  - Contrast Agents
  - Echocardiography
  - RF Technologies
- Catheterization Procedures
  - Angiography/Angioplasty/Stents
  - Valvuloplasty
  - Mitral Clip
  - TAVR
- Electrophysiology Procedures
  - Anesthetic Impacts on Electrophysiology
  - Pacemaker Management
  - Pacer/ICD Implantation
  - Generator Change
  - Lead Removal
  - Cardioversion
  - VT Ablation
  - SVT Ablation
  - Afib Ablation

Cath Lab Environment – Contrast Agents

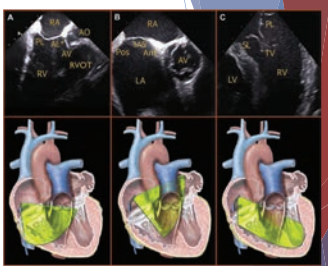
- Types of adverse reactions
  - Hypersensitivity
    - Acute (mild <3%, moderate-severe <0.04%)
    - Delayed, >1hr, typically rash (intra-arterial 10-14%)
  - Thyroid dysfunction (all rare)
    - Thyrotoxicosis (Graves and multinodular goiter)
  - Contrast Induced Nephropathy (CIN)

Cath Lab Environment – Contrast Agents

- Risk factors for CIN
  - Age >65yo
  - Anemia
  - Kidney Disease (eGFR<60) (15-55%)
  - Diabetes (6-29%)
  - Nephrotoxic drug use (e.g. aminoglycosides, NSAIDs, amphotericin, cisplatin)
  - Intra-arterial worse than IV
- CIN Risk Reduction
  - High vs Low Osmolality Contrast (5-12% vs 1-3%)
  - Gadolinium vs iodinated contrast between 1/8 and 1/4 risk
  - For high risk patients: NS or at 1mL/kg/hr for 6-12hrs before contrast and 12-24hrs after
  - PO fluid 500mL before and 2,500 mL for 24hrs after

Cath Lab Environment - Echocardiography

- Transthoracic Echocardiography (TTE)
- Transesophageal Echocardiography (TEE)
- Intracardiac Echocardiography (ICE)
  - Limited Far-field imaging
  - Limited 3D capabilities
  - No bi-plane imaging
  - Good for intra-atrial septum defect closure
  - Emerging data for LAA occlusion, TAVR



Alkhouli, et al. JACC: Cardiovascular Interventions (2018)

Cath Lab Environment – RF Exposure

Study Type	Patient Median Exposure (mSv)	Patient Exposure Range (mSv)
Diagnostic EP Study	3.2	1.3-23.9
Afib Ablation	16.6	6.6-59.6
SVT Ablation	4.4	1.6-25.0
VT Ablation	12.5	3.0-45.0
Pacemaker Implant	4	1.4-17.0
CRT Implant	22	2.2-95.0
Coronary Angio	7	2.0-16.0
PCI	15	7.0-57.0

Cine – 5% of the time, 60% of the dose

Protective measures	Reduction
Traditional lead	90-95%
Leaded Glasses	87-98%
Lead caps	3.30%
Gloves	20-50%
Radiation-blocking cream	85%
Shield, curtain	~90%
Distance	1/distance^2

Type of dose limit	Limit on dose from occupational exposure[1]
Effective dose	20 mSv/yr averaged over 5 consecutive years and 50 mSv in a single year
Effective dose on pregnancy	The dose to embryo/fetus should not exceed 1mV during remainder of pregnancy
Equivalent dose: Lens of the eye	20 mSv/yr averaged over 5 consecutive years and 50 mSv in a single year
Equivalent dose: Skin	500 mSv/yr
Equivalent dose: Extremities (hands and feet)	500 mSv/yr

Increasing your distance to 100% further than patient reduces exposure by 75%

Catheterization Procedures

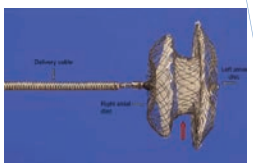
- Angiography/Angioplasty/Stents
- Percutaneous Closure of ASD
- Valvuloplasty
- Mitral Clip
- TAVR
- Thromboembolectomy

Catheterization Procedures

- Angiography/Angioplasty/Stents
  - Typically performed with light sedation and local anesthesia
  - Anesthesiology called due to multiple comorbidities, heart failure, respiratory distress, acute MI
- Patient's NPO status may lead to ETT being preferred over LMA if continuation of light sedation is not possible
- When called due to iatrogenic pericardial effusion without infectious concern, consider pericardiocentesis by cardiology with the blood returned directly to a patient IV
- Collaboration is key when called non-emergently

Catheterization Procedures

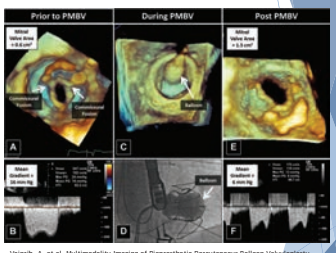
- Percutaneous Closure of ASD
  - TEE is used
  - GETA
  - Possible Complications
    - Arrhythmias
    - AV Conduction defect
    - Device Embolization
    - RV dysfunction and pulmonary hypertension may worsen



Amplatzer Septal Occluder Device

Catheterization Procedures

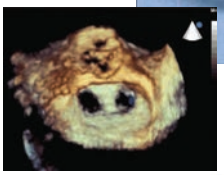
- Valvuloplasty (Success Rate ~85%)
  - General or MAC depending on the patient conditions
    - If TEE, then general
    - High institutional variation
  - Transient acute decrease in cardiac output
  - Complications for Mitral Valve
    - Regurg (8%)
    - ASD (2%)
    - Stroke (<1%)
    - Valve rupture (<1%)
    - Tamponade (<1%)
    - Conduction Issues (<1%)



Vainrib, A, et al. Multimodality Imaging of Bioprosthetic Percutaneous Balloon Valvuloplasty Followed by Valve-in-Valve Implantation for Mitral Stenosis Due to Commissural Leaflet Fusion. J Am Coll Cardiol Intv. 2016 https://doi.org/10.1016/j.jcin.2015.11.043

Catheterization Procedures

- Mitral Clip
  - A-line per patient condition and ACT practices
  - TEE
  - GETA
  - Complications (<3.5% major adverse events)
    - Mortality (<0.1%)
    - Persistent ASD (50% at 6mo 25% at 12mo)
    - Mitral Stenosis (15%, range 1-35%)
    - Myocardial Infarction (0-3%)
    - Damage to chordae or leaflet (0-2%)
    - Stroke (0-1%)
    - Clip embolization (0.1-0.7%)
    - Pericardial Effusion (0-0.5%)



Annals of Cardiac Anaesthesia17(1):17-22, January-March 201

Catheterization Procedures

- TAVR
  - Blood Available
  - Large Bore PIV
  - Arterial line (varies on whether accessed by cardiology vs anesthesiology)
  - Echocardiography
  - General and MAC both used
  - Complications
    - Mortality (1.5%)
    - Myocardial Infarction (0.5%)
    - Perivalvular leak (1.75%)
    - Stroke (<2%)
    - AV Node Dysfunction (14% from 2008-2018)
    - Myocardial stunning from rapid pacing
    - Pericardial Effusion

TAVR procedure: the illustration shows the new aortic valve being placed in position with a cardiac catheter
Source: Edwards Lifesciences

Electrophysiology Procedures

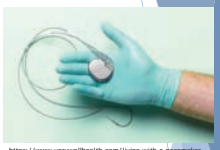
- Anesthetic Impacts on Electrophysiology
- Pacemaker Management
- Pacer/ICD Implantation
- Generator Change
- Lead Removal
- Cardioversion
- VT Ablation
- SVT Ablation
- Afib Ablation

Electrophysiology Procedures

- Anesthetic Impacts on Electrophysiology
  - Propofol
    - minimal effects on QT interval and conduction system.
    - represses catecholaminergic activity,
    - inhibits ion channels of myocardium.
  - Volatile anesthetics
    - Some prolongation effects on QT interval
    - Use with propofol will reverse its effect on QT interval
    - Reduction of ischemic and reperfusion arrhythmias
  - Dexmedetomidine
    - may suppress supraventricular arrhythmias

Electrophysiology Procedures – Pacemaker Management

- Yes/No Defibrillator
- Will there be electromagnetic Interference
  - Will Interference be of significant duration
  - Will the pathway be within 15cm of the device or leads
- Is the patient pacemaker dependent?
- Who manufactures the pacemaker?
- Will a magnet do what you want and is it feasible for the procedure?
- Assess available data: EKG, CXR, Interogation Report, Cardiology Notes
  - Pacemaker App (pacemakerid.com)



https://www.verywellhealth.com/living-with-a-pacemaker-1746228

Electrophysiology Procedures – Pacemaker Management

- If you are disabling defibrillation, then consider applying cutaneous defib pads
- Magnet Application
  - If defibrillator, then disables defib function only (magnet does not impact pacing functions)
    - If this is a Boston Scientific PRIZM Device, Tachy Therapy may also be impacted
    - Boston Scientific and Medtronic give audio feedback with magnet placement
  - If no defibrillator and is NOT Biotronik, then asynchronous pacing should begin
  - If no defibrillator and is Biotronik, then asynchronous pacing may not be maintained
  - Default Rates for pacemakers without defibrillators (note: this may be changed)
    - Medtronic 85 bpm
    - Boston Scientific 100 bpm
    - St. Jude 100 bpm
    - Sorin 96 bpm
- Consider the patient's native rate prior to initiating asynchronous pacing

Electrophysiology Procedures – Pacemaker Management

- When to interrogate post-operatively
  - Pre-op programming changes
  - External defibrillation was used
  - Possible device damage or dysfunction
  - If otherwise clinically indicated
  - Consider if magnet was applied intraoperatively
- Manufacturer Contacts
  - Medtronic (800) 878-5616
  - Guidant/Boston Scientific (800) 227-3422
  - St. Jude (800) 722-3423
  - Biotronik (800) 547-0394
  - Sorin (877) 663-7674

https://link.springer.com/chapter/10.1007/978-3-030-95259-4_26

Electrophysiology Procedures – Pacemaker Management

- Leadless Pacemakers
  - Medtronic Micra
    - Does not respond to magnet
    - Modes:
      - VVI, VVIR, VOO, OVO, OFF
  - Medtronic Micra AV
    - Does not respond to magnet
    - Modes:
      - VVI, VVIR, VOO, OVO, OFF
      - Plus - VDD, VDI (atrial sensing via accelerometer)
  - Abbott Aveir
    - Does (by default) respond to Magnet
      - Initially 100 bpm and then rate depends on battery charge between 100bpm and 85 bpm
      - Modes:
      - VVI, VOO

https://www.medgadget.com/2016/04/medtronics-tiny-micra-leadless-pacemaker-approved-in-u-s.html

Electrophysiology Procedures

- Pacer/ICD Implantation
  - placed percutaneously under mild to moderate sedation
  - For ICD testing by delivering shocks, deep sedation or general anesthesia
  - For ICDs, Defib pads
    - Defib after inducing Vfib
    - Possible pacing due to bradycardia after defib
  - Complications
    - Cardiac perf
    - Myocardial Injury
    - Stroke
    - Pneumothorax due to Subclavian Access

https://www.medtronic.com/us-en/patients/treatments-therapies/icd-devices/implant-procedure.html

Electrophysiology Procedures

- Generator Change
  - placed percutaneously under mild to moderate sedation
  - For ICD testing by delivering shocks, deep sedation or general anesthesia
  - For ICDs, Defib pads
    - Defib after inducing Vfib
    - Possible pacing due to bradycardia after defib

Electrophysiology Procedures

- Lead Extraction (note: removal refers to a procedure for a lead <1yr old)
  - MAC for Low Risk, GETA for Intermediate and High Risk
  - High Institutional Variation with Intermediate and High Risk
    - A-Line, Vascular Access, TEE, Blood Availability
  - Low Risk (EROS Scale)
    - Pacer Leads <15yrs old, ICD Leads <10yrs old
    - Not Dual Coil ICD Leads
  - High Risk
    - Pacer Leads >15yrs old, ICD Leads >10yrs old
    - Dual Coil ICD Leads
  - Intermediate Risk – Otherwise meet low risk criteria but with the following patient conditions
    - Congenital heart disease
    - Initial Implant when patient was <15yo
    - Cr >2mg/dL
    - WBC > 12, Positive Blood Culture, Vegetations on Echo
    - NYHA Class IV
  - Reasons for extraction
    - Infection (~53%)
    - Lead recall/malfunction
    - Venous access issues
    - Severe TR
    - MRI/radiotherapy

Electrophysiology Procedures

- Cardioversion
  - Without TEE
    - Supplemental oxygen
    - Airway equipment available
    - Bite block in place
    - Very brief (less than a minute): Deep sedation vs General without airway
    - Prepare for bradycardia if cardioversion is successful and patient is beta blocked
  - With TEE
    - Same as above, except to procedure lasts longer
    - Consider topicalization to reduce the sedation requirement

https://acls.com/articles/about-synchronized-cardioversion/

Electrophysiology Procedures

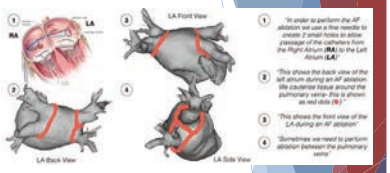
- Ablation Procedures
  - Potential Complications (Intra-op Consideration)
    - Cardiac Perforation +/- Tamponade,
    - Valve Damage,
    - Heart Block,
    - Myocardial Infarction,
    - Thromboembolism
    - Esophageal Thermal Injury (Esophageal Temp Sensor)
    - Fluid Overload during RFA procedures (Consider Lasix)
  - Defibrillation pads in place

Electrophysiology Procedures

- VT Ablation
  - Often, light sedation for the mapping portion of procedure then deepen
    - Epicardial ablation typically general anesthesia
    - Endocardial typically MAC for stable, general for less stable patients
  - Often with arterial line
  - Support of hemodynamics during electrical stimulation (PES/NIPS/CIED)
  - End organ disfunction in unstable VT patients (lactate, potassium, etc.)
- SVT Ablation
  - Typically, under moderate sedation

Electrophysiology Procedures

- Afib Ablation
  - GETA
  - High frequency jet ventilation (HFJV) can reduce chest wall movement and left atrial volume changes
  - A-line only if patient condition warrants
  - 2nd PIV, heparinization indicated
  - No paralysis redosed after induction to monitor phrenic nerve
  - Esophageal temperature probe
  - Minimize fluids (Lasix may be needed)



https://www.melbourneheartrhythm.com.au/learn/procedures/13-atrial-fibrillation-ablation?showall=1

Afib Ablation Early Complications

Pericardial effusion (1.2-1.3%)	Stroke (1-2% within 24 hrs)	Phrenic nerve palsy (right)(<0.5%)
• Tamponade (0.9%) • Immediate perc. Drainage • Consider anticoagulation reversal	• Risk increases with left atrial size • Observe for signs after emergence	• During right pulmonary vein and/or SVC isolation • Higher risk with cryo than RF ablation

Afib Ablation Delayed Complications

Pulmonary vein stenosis

Historically high incidence, up to 40%

Incidence is now near zero

Present weeks to months after procedure

- cough, chest pain, dyspnea, hemoptysis, recurrent pulmonary infections, new pHTN

Atrial esophageal fistula (0.1%)

Present 2-4 weeks post-procedure

During left atrial posterior wall ablation

Questions?