CO₂ USE IN ENDOVASCULAR AORTIC ANEURYSM REPAIR

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USING CO₂ CONTRAST FOR IMAGING FOR AORTIC AND ILIAC INTERVENTIONS

- WHY USE?
- SAFETY OF CO₂ USE
- BENEFITS IN REDUCTION OF COMPLICATIONS
- APPROACH TO AAA REPAIR IN PATIENTS WITH COMPROMISED RENAL FUNCTION
OPEN VS. ENDOVASCULAR REPAIR OF AAA

• MOST BENEFIT IS IN THE PATIENT WITH THE HIGHEST CO-MORBIDITIES
• SURVIVAL IN RUPTURED ANEURYSMS IS GREATER WITH EVAR
• PATIENTS WHO ARE THE MOST ILL, ARE THOSE THAT OPEN SURGERY WOULD BE THE LEAST DESIRABLE OPTION.
• CHRONIC RENAL INSUFFICIENCY IS A SIGNIFICANT COMORBIDITY IN THIS GROUP OF PATIENTS.
CHRONIC RENAL FAILURE AND ABDOMINAL AORTIC ANEURYSM

EVAR WAS CONSIDERED A CONTRINDICATION BECAUSE OF CONTRAST INDUCED RENAL INJURY AND WORSENING RENAL FUNCTION.

KNOWLEDGE ABOUT CO$_2$ ARTERIOGRAPHY WAS LIMITED AND FAILURES OF ATTEMPTS IN USE CAUSED IT TO NOT BE USED BY MANY.

DELIVERY SYSTEMS WERE RUDIMENTARY, AND FEAR OF COMPLICATIONS WERE ALSO A FACTOR.
SAFETY OF CO$_2$ IN ENDOVASCULAR ABDOMINAL AORTIC ANEURYSM SURGERY GOALS

- ADEQUATELY IMAGE TO SAFELY DO SURGERY
- EFFECTIVELY PREVENT WORSENING OF RENAL FUNCTION
- NO COMPLICATIONS FROM ITS USE
CASE REPORTS OF EVAR WITH CO$_2$

- GAHLEN, HANSMANN, SCHUMACHER, ET AL FROM HEIDELBURG REPORTED ON THREE PATIENTS WHERE EVAR WAS DONE WITH CO$_2$ AS IMAGING AGENT
- TWO PATIENTS HAD CHRONIC RENAL INSUFFICIENCY, AND ONE A SEVERE CONTRAST ALLERGY
- REPORTED TECHNIQUE AND TECHNICAL SUCCESS
EARLY EXPLORATION FOR ALTERNATIVE TECHNIQUES FOR EVAR IN RENAL COMPROMISED PATIENTS

• BUSH, LIN BIANCO, ET AL REPORTED IN JOURNALS OF VASCULAR SURGERY IN 2002; ON THE USE OF ALTERNATIVE IMAGING IN PATIENTS WITH SEVERE CONTRAST ALLERGY OR RENAL DYSFUNCTION USING NON-IODINATED CONTRAST TECHNIQUES. REPORTED THIS GROUP OF 20 PATIENTS OUT OF A TOTAL NUMBER OF 297 PATIENTS

• USED IVUS AND SOME MRA, CT, AND CO₂

• FELT WITH THE COMBINATION OF THESE MODALITIES EVAR COULD SAFELY BE PERFORMED

• USED DUPLEX SCANNING FOR POST OPERATIVE SURVEILLANCE OF ENDOLEAKS.
CAN EVAR SAFELY BE DONE WITH MINIMAL OR NO IODINATED CONTRAST AGENT?

- CHAO, MAJOR, KUMAR ET. AL. 2006; REPORTED OUT OF A GROUP OF 100 CONSECUTIVE PATIENTS; A GROUP OF 16 THAT HAD CO₂ AND A MEAN OF 27 CC OF IODINATED CONTRAST COMPARED TO 148 CC IN THE OTHER GROUP WITH NORMAL BASELINE CREATININE.
- THE MEAN SERUM CREATININE DID NOT CHANGE IN EITHER GROUP.
CAN CO$_2$ PROVIDE ADEQUATE IMAGING FOR EVAR

- LEE AND HALL IN 2010 REPORTED ON 17 PATIENTS WHERE CO$_2$ WAS USED IN ALL PATIENTS
- ADEQUATELY IMAGED THE AORTIC BIFURCATION IN ALL CASES
- RENAL ANATOMY IN 9 OF THE 17 PATIENTS.
- MEDIAN CONTRAST USED WAS 59 CC.
LARGEST SERIES OF CO₂ USE IN EVAR

- CRIADO, UPCHURCH, YOUNG, ET AL IN JVS 2012 REPORTED ON 114 CONSECUTIVE PATIENTS UNDERGOING EVAR WITH CO₂.
- 72 CO₂ ALONE; 42 COMBINATION OF AGENTS WITH MEAN OF 37 CC OF IODINATED CONTRAST AGENTS USED.
- COMPARED WITH A SIMILAR COHORT WHERE IODINATED CONTRAST USED; THE GFR DECREASED 12.7% GREATER IN THE IOD CONTRAST GROUP.
ADEQUATE EQUIPMENT FOR CO$_2$ EVAR

- RELIABLE CO$_2$ DELIVERY SYSTEM; CO$_2$ COMMANDER HAS MADE DELIVERY SAFE AND SIMPLE
- ENDO-SUITE WITH PROGRAMMING FOR C$_0$$_2$ ARTERIOGRAPHY
- SOME MOBILE C-ARMS HAVE CO$_2$ PACKAGE; BUT IT IS MUCH MORE DIFFICULT TO OBTAIN ADEQUATE IMAGING.
DELIVERY SYSTEMS; FOR CO$_2$ AS AN IMAGING AGENT

• USED THE BAG RESEVIOR COLLECTION SYSTEM FOR YEARS. COMPONENTS HAVE TO BE PURCHASED INDIVIDUALLY; AND TREMENDOUS FEAR OF MIS-HANDLING OF COLLECTION OF AIR EMBOLISM

• NOW USE CO$_2$ COMMANDER SYSTEM

• NOW USED AT ALL MAJOR HOSPITALS IN THE KANSAS CITY AREA.
ADEQUATE OR SPECIFIC TRAINING IN TECHNIQUES

- KNOWLEDGE OF SAFETY ISSUES OF CO₂ AND DIFFERENCE BETWEEN C₀₂ AND AMBIENT AIR
- RESPIRATORY CONTROL OF THE PATIENT!!
- BOWEL GAS MANAGEMENT
- END INJECTION CATHETER TECHNIQUES.
- PATIENCE!! TRY ANOTHER RUN, IF FIRST IS INADEQUATE, OR IF THE PATIENT BREATHES.
EXTEND CONCEPT OF MINIMIZING IODINATED CONTRAST TO PRE-OP EVALUATION

• GENERALLY FOLLOW PATIENT WITH AAA WITH ABDOMINAL ULTRASOUNDS

• IN PATIENTS WITH GROWTH OF SAC OR COMPLICATION THAT SUGGESTS REPAIR IS APPROPRIATE; USE HIGH QUALITY NON-CONTRAST CT SCAN OR MRI TO DELINEATE ANATOMY

• SPECIFICALLY ADEQUATE INFRA-RENAL NECK FOR SEAL
PRE-OP EVALUATION (CONT.)

• RENAL ARTERY LOCATION AND NUMBER OF VESSELS
• DIAMETER OF ARTERIES, AND LENGTH OF POTENTIAL GRAFT REQUIRED TO REPAIR THE ANEURYSM
• ASSESS ILIAC LANDING ZONES
• TOTAL SYSTEM TO MINIMIZE IODINATED CONTRAST
CO$_2$ INITIAL RUN FOR EVAR
CO₂ SECOND IMAGE; SAME RUN
CO2 IMAGES CLEARLY SHOW LOCATION OF RENAL ARTERIES, AND ADEQUATE LENGTH OF INFRA-RENAL AORTIC SEAL ZONE
RETROGRADE RIGHT ILIAC FOR LIMB LENGTH DETERMINATION
CONTRALATERAL LIMB LENGTH MEASUREMENTS
COMPLETION IMAGE OF EVAR WITH CO₂
ASSESS FOR RENAL PROFUSSION; LIMB CONSTRAINT AND FLOW; AND ENDOLEAKS
DILUTE IODINATED CONTRAST IMAGE CONFIRMING CO2 IMAGE IMPRESSION; COMFRIMS RESULTS
NOT ALL CO$_2$ IMAGES ARE ADEQUATE
PITFALLS TO USE OF CO$_2$ IN AORTIC IMAGING

• SEDATION LEVEL OF PATIENT:

  GENERAL ANESTHESIA WITH RESPIRATIONS CONTROLLED

  MINIMAL SEDATION WITH THE PATIENT AWAKE STOPPING RESPIRATIONS ON REQUEST.
IMPACT OF BOWEL GAS ON IMAGING

- ACTIVE PERSITALSIS; SUCH AS FROM PRE-OP PREP MAKES IMAGING DIFFICULT. EVACUATION OF GAS HELPS WITH VISUALIZATION.
- LARGE AMOUNTS OF SMALL BOWEL GAS SUCH AS WITH ILEUS MAKE IMAGING ALMOST IMPOSSIBLE.
- DISTENDED COLON OR GI CONTRAST
- DISTENDED STOMACH
- ALL INTERFERE WITH IMAGING.
CO$_2$ ARTERIOGRAPHY IN REVISION EVAR SURGERY

- Goal to minimize, if not eliminate, need of iodinated contrast
- Goal is to stay at less then 30cc of iodinated contrast
- Most common situation is combination imaging
- Proximal and distal extension of grafts
- To detect endoleaks
CO2 IMAGING DEMONSTRATING SLIPPED ENDOGRAFT
ANOTHER SLIPPED EVAR; IF CO2 IS NOT ADEQUATE USE A CONFIRMATORY IC RUN
DILUTE IODINATED CONTRAST IMAGE TO BETTER DELINEATE HYPOGRASTIC ANEURYSM
CO2 USED TO CONFIRM ADEQUATE EMBOLIZATION AND PLAN EXTENSION
CO2 USED FOR LEFT LIMB COMPLETION STUDY
WHAT IS THE STATE OF THE ART?

EVAR IN PATIENTS WITH RENAL IMPAIRMENT OR SERIOUS IODINATED CONTRAST ALLERGY
CURRENT PROTOCOL OF EVALUATION FOR AAA IN PATIENTS WITH RENAL IMPAIRMENT OR SEVERE CONTRAST ALLERGY

• HIGH QUALITY CT FOR PRE-OP EVALUATION
• IF INADEQUATE IMAGING TO FEEL EVAR IS POSSIBLE CO₂ DIAGNOSTIC ARTERIOGRAM
• CO₂ AS PRIMARY IMAGING AGENT FOR INTRA-OPERATIVE IMAGES.
• USE SMALL AMOUNTS OF IODINATED CONTRAST IF REQUIRED; WITH THE GOAL TO STAY UNDER TOTAL OF 20 CC’S
• CT AND DUPLEX USED FOR POST-PROCEDURE FOLLOW-UP FOR ENDOLEAK EVALUATION AND GRAFT SURVEILLANCE
NON-CONTRAST CT SHOWS RENAL ARTERIES
LOOK FOR GRAFT-WALL CONTACT, WITH NO DISTANCE BETWEEN
ILIAC ARTERY GRAFT CONNECTION, AND NO NEW EXPANSION OF ILIAC ARTERY ANEURYSMS ALONG WITH ANEURYSM SAC DIAMETER
ADD CLINICAL EXAM AND DUPLEX SCANS AS PART OF FOLLOW-UP FOR EVAR PATIENTS; NOT UTILIZING IODINATED CONTRAST AGENTS

- CHANGES IN SYMPTOMS; SUCH AS NEW BACK OR ABDOMINAL PAIN
- DUPLEX SCANS ARE EXTREMELY HELPFUL IN ON COLOR FLOW VISUALIZING JETS OF AN ENDOLEAK
- REMEMBER TO CHECK ON PHYSICAL EXAM FOR THE DEVELOPMENT OF POPLITEAL OR FEMORAL ANEURYSMS AS PART OF EVAR FOLLOW-UP FOR LIFE
PREFERRED EQUIPMENT, AND SITUATION FOR PERFORMING EVAR WITH CO$_2$ IMAGING

• AWAKE OR ASLEEP PATIENT
• MINIMIZE BOWEL GAS
• CO$_2$ COMANDER FOR DELIVERY OF GAS. BAG RESERVOIR REMAINS AN EMERGENCY BACK-UP IF REQUIRED. (I FILL MY OWN BAGS)
• FIXED UNIT; HYBRID OR SUITE
• PRE-MEDICATE PATIENTS WITH CONTRAST ALLERGY INCASE IODINATED CONTRAST IS NEEDED AS AN ADJUNCTIVE AGENT.
• HELP SAVE PATIENTS FROM RENAL FAILURE.
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