

CO2 IN AORTIC INTERVENTIONS

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19th Annual Conference

2018
May 30 - June 01

THE PERIPHERAL EVENT OF THE YEAR



96 Year Old Retired High School Librarian

- Lives independently
- Smoked one pack a day all adult life.
- Stage III CKD
- CAD
- COPD
- Abdominal pain
- Tender over AAA

NON-CONTRAST CT SCAN

Scr: 2/Img: 37
Loc: 130 mm
40 /400
FFS

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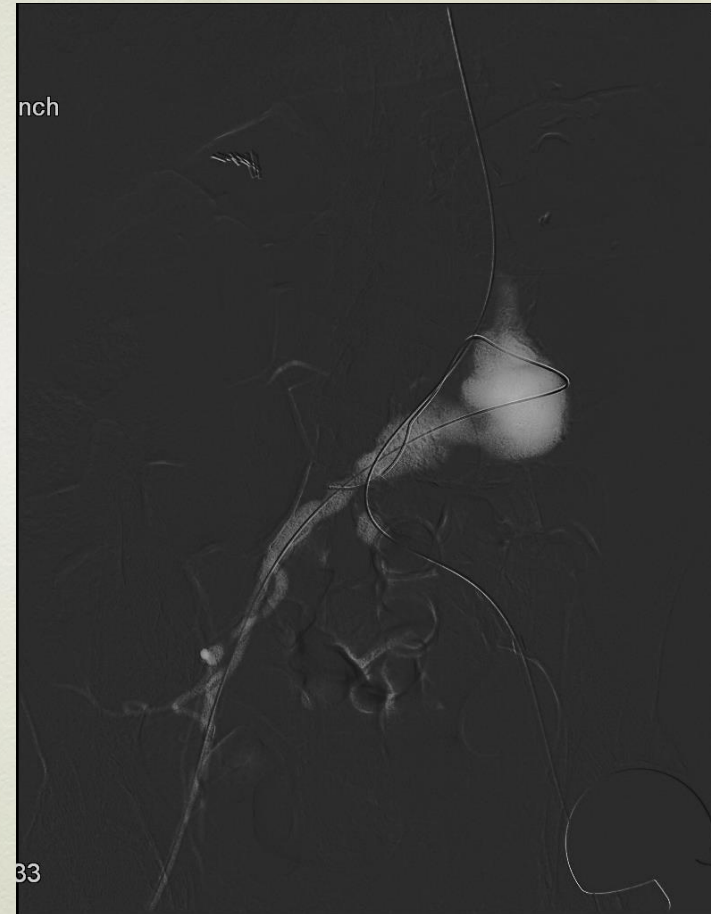
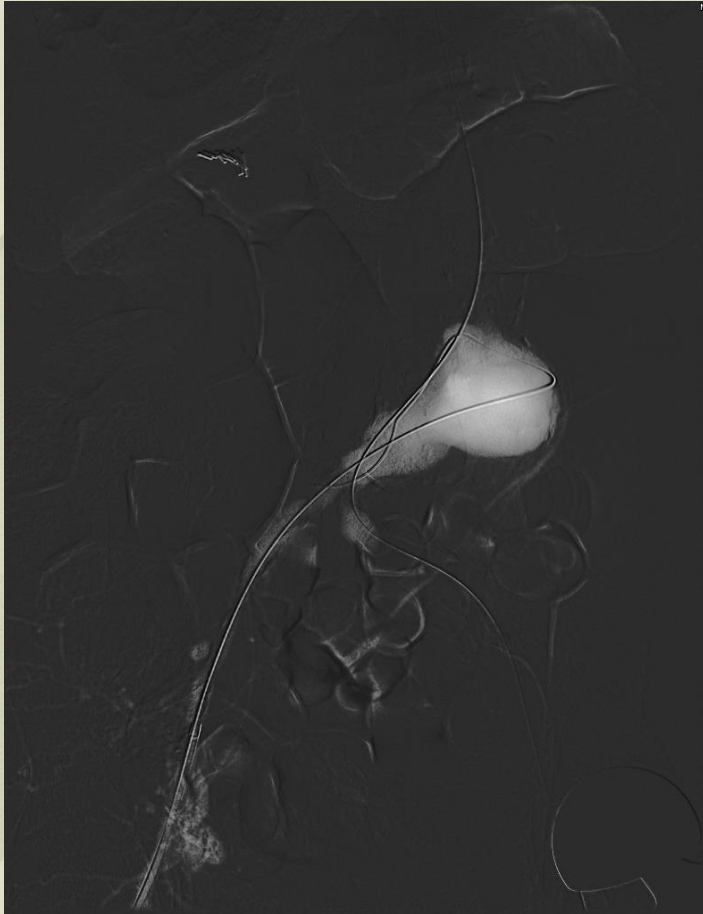


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500 msec
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Thk: 5 mm/FOV: 40 cm
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WITHOUT

Iliac stenosis found and treated as first step toward endograft positioning



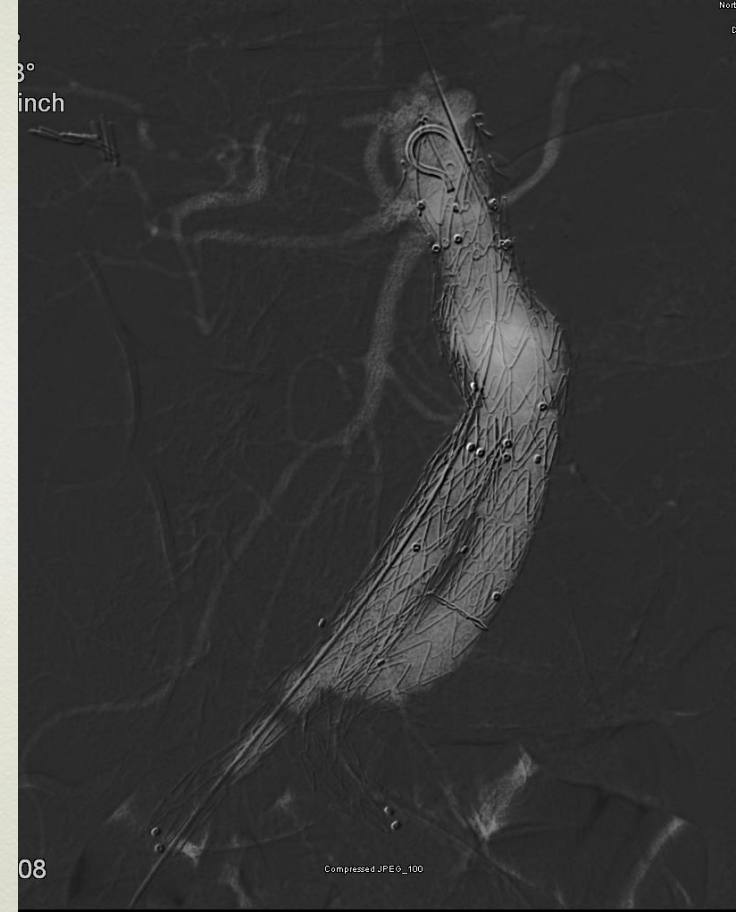
Sizing, and initial deployment positioning



Deployment of graft and contralateral limb



Imaging reveals the main body to be more distal than it appeared. Extended with an aortic cuff.



USING CO₂ CONTRAST FOR IMAGING FOR AORTIC AND ILIAC INTERVENTIONS

- WHY USE? TODAY; WHY AREN'T YOU USING.
- SAFETY OF CO₂ DIRECTLY RELATED TO DELIVERY OF THE AGENT.
- 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.

OPEN VS. ENDOVASCULAR REPAIR OF AAA

- GREATEST BENEFIT IS IN THE PATIENT WITH THE HIGHEST CO-MORBIDITIES.
- SURVIVAL BENEFIT IN RUPTURED ANEURYSMS IS GREATER WITH EVAR THEN ANY OTHER GROUP OF PATIENTS.
- 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.

SAFETY OF CO₂ IN ENDOVASCULAR ABDOMINAL AORTIC ANEURYSM SURGERY GOALS

- ADEQUATELY IMAGE VESSELS TO SAFELY DO PROCEDURE.
- EFFECTIVELY PREVENT WORSENING OF RENAL FUNCTION
- NO COMPLICATIONS FROM ITS USE

CASE REPORTS OF EVAR WITH CO₂

- GAHLEN, HANSMANN, SCHUMACHER, ET AL FROM HEIDELBURG REPORTED ON THREE PATIENTS WHERE EVAR WAS DONE WITH CO₂ 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 CO₂ PROVIDE ADEQUATE IMAGING FOR EVAR

- LEE AND HALL IN 2010 REPORTED ON 17 PATIENTS WHERE CO₂ 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 IODINATED CONTRAST GROUP.

ADEQUATE EQUIPMENT FOR CO₂ EVAR

- RELIABLE CO₂ DELIVERY SYSTEM
- USED BAG COLLECTION KIT FOR YEARS.
- CO₂ COMMANDER HAS MADE DELIVERY SAFE AND SIMPLE
- ENDO-SUITE WITH PROGRAMMING FOR CO₂ ARTERIOGRAPHY
- SOME MOBILE C-ARMS HAVE CO₂ PACKAGE; BUT IT IS MORE DIFFICULT TO OBTAIN ADEQUATE IMAGING.
- CAN'T REPROCESS IMAGES WITH THESE MOBILE UNITS.

WHAT IS ADEQUATE EQUIPMENT FOR CO₂ EVAR

- RELIABLE CO₂ DELIVERY SYSTEM; CO₂ COMMANDER HAS MADE DELIVERY SAFE AND SIMPLE
- IN KANSAS CITY ALMOST ALL HOSPITALS HAVE AT LEAST ONE UNIT.
- ENDO-SUITE WITH PROGRAMMING FOR CO₂ ARTERIOGRAPHY ARE DEFINITELY THE BEST.
- SOME MOBILE C-ARMS HAVE CO₂ PACKAGE; BUT IT IS MORE DIFFICULT TO OBTAIN ADEQUATE IMAGING.
- PATIENT CONSIDERATIONS FOR TYPE OF UNIT; LARGE OBESE PATIENTS OR COM;PLE REPAIRS; WE WILL MOVE TO A HOSPITAL WITH A HYBRID OR SUITE
- ENDOGRAFT AVABILITY ALSO FACTORS INTO THIS DECISION.

ADEQUATE OR SPECIFIC TRAINING IN TECHNIQUES

- KNOWLEDGE OF SAFETY ISSUES OF CO₂ AND DIFFERENCE BETWEEN CO₂ AND AMBIENT AIR.
- UNDERSTAND THE MECHANISM OF THE DELIVERY SYSTEM, AND SAFETY MEASURES TO PREVENT DELIVERY OF ROOM AIR.
- RESPIRATORY CONTROL OF THE PATIENT!!
- BOWEL GAS MANAGEMENT
- INJECTION CATHETER TECHNIQUES GENERALLY USED; BUT FLUSH CATHETERS DO WORK, WHEN LIMITING EXCHANGES.
- PATIENCE!! TRY ANOTHER RUN IF THE FIRST IS INADEQUATE, OR IF THE PATIENT BREATHES.

PRE-OP EVALUATION

- RENAL ARTERY LOCATION AND NUMBER OF VESSELS
- DIAMETER OF ARTERIES, AND LENGTH OF POTENTIAL GRAFT LANDING ZONES REQUIRED TO REPAIR THE ANEURYSM
- ASSESS ILIAC LANDING ZONES AND HYPOGASTRIC ARTERY PATENCY.
- TOTAL SYSTEM TO *MINIMIZE* IODINATED CONTRAST

CO₂ INITIAL RUN FOR EVAR



CO₂ SECOND IMAGE; SAME RUN

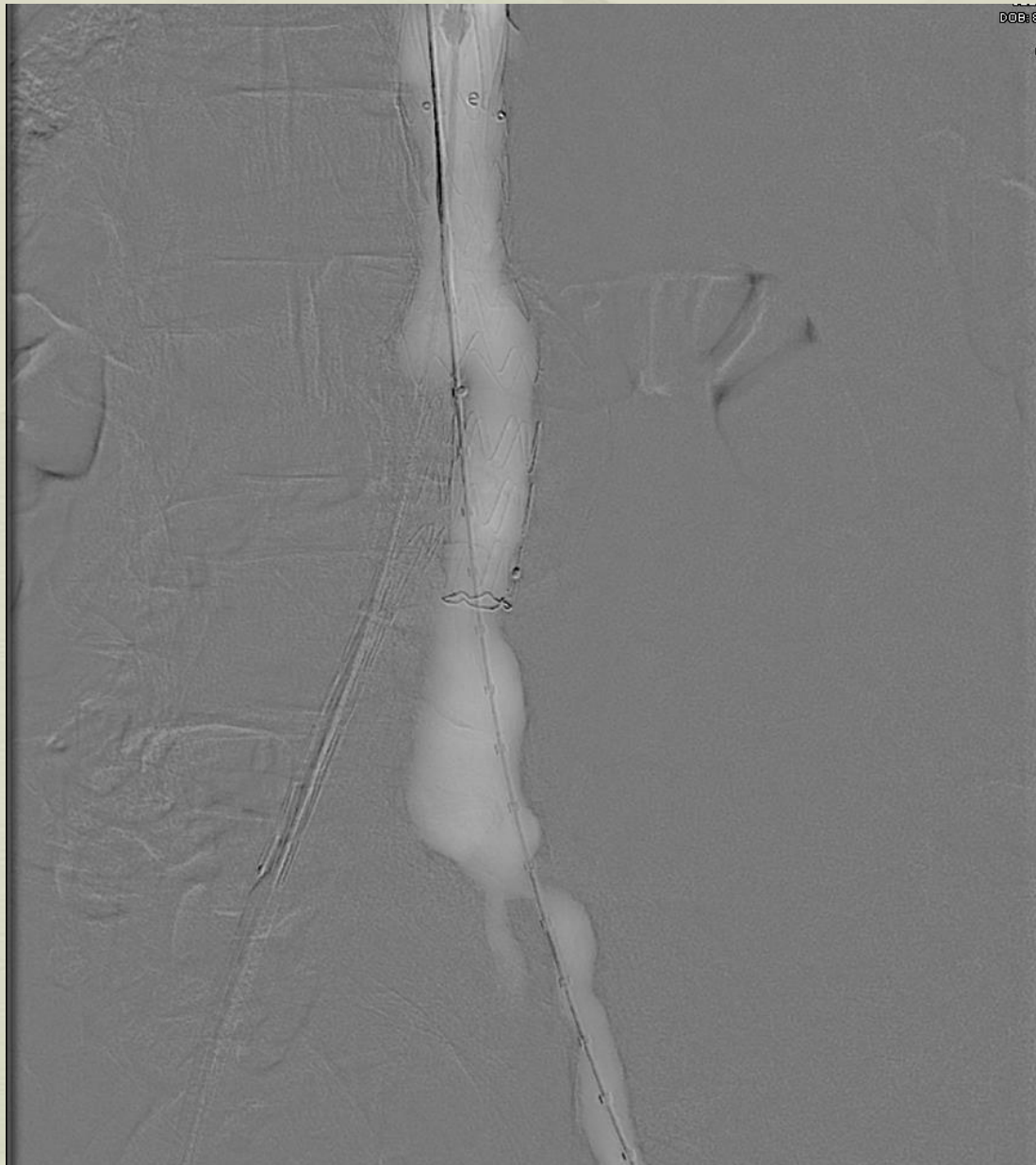


CO2 IMAGES CLEARLY SHOW LOCATION OF RENAL ARTERIES, AND ADEQUATE LENGTH OF INFRA-RENAL AORTIC SEAL ZONE



RETROGRADE RIGHT ILIAC FOR LIMB LENGTH DETERMINATION





CONTRALATERAL LIMB LENGTH MEASUREMENTS



COMPLETION IMAGE OF EVAR WITH CO₂

ASSESS FOR RENAL PERFUSION; LIMB CONSTRAINT AND FLOW; AND ENDOLEAKS

DILUTE IODINATED CONTRAST IMAGE CONFIRMING CO2 IMAGE IMPRESSION; CONFIRMS RESULTS



NOT ALL CO₂ IMAGES ARE ADEQUATE



PITFALLS TO USE OF CO₂ 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 PERISTALSIS ; 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.

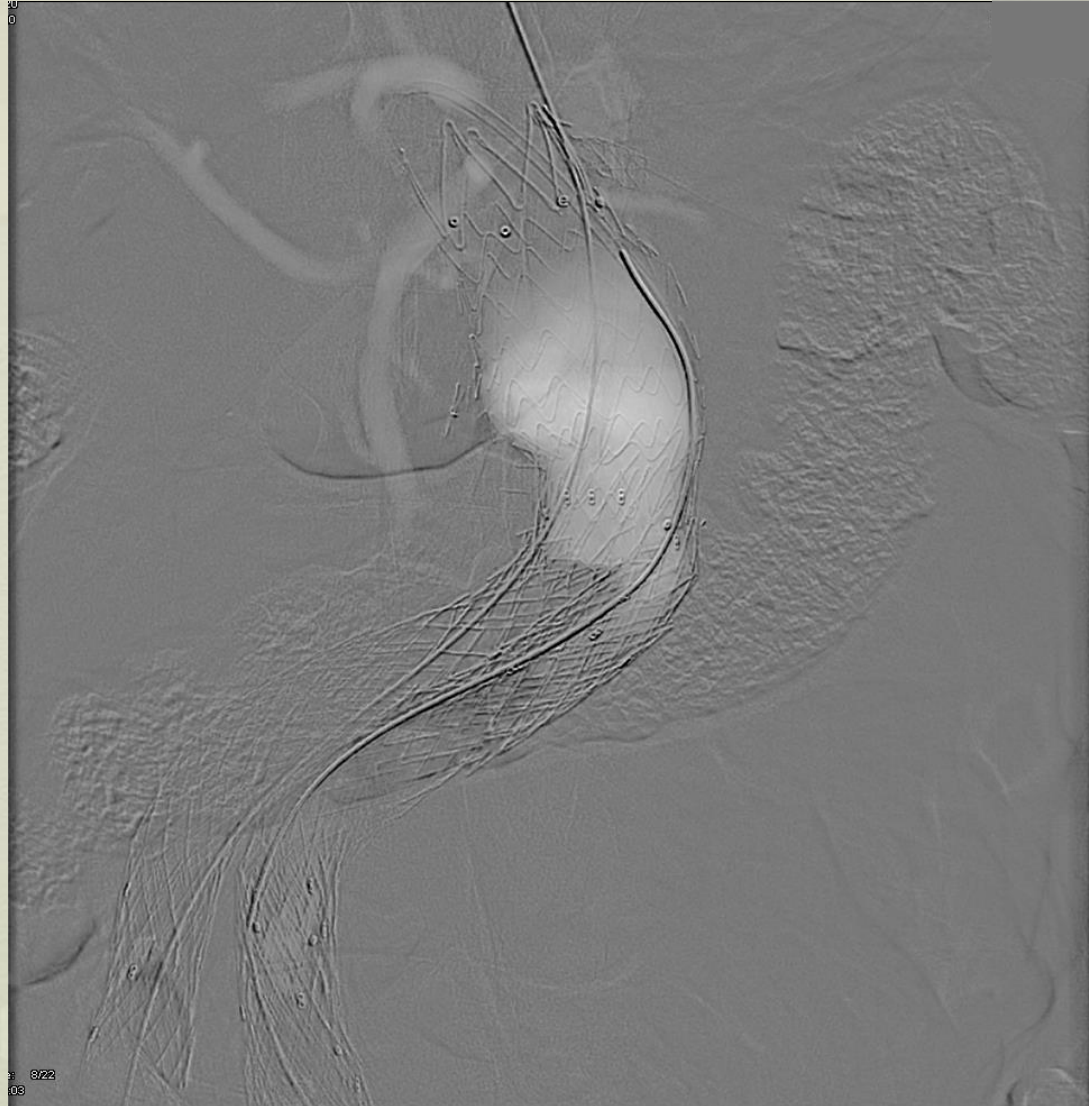


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CO₂ ARTERIOGRAPHY IN REVISION EVAR SURGERY

- 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

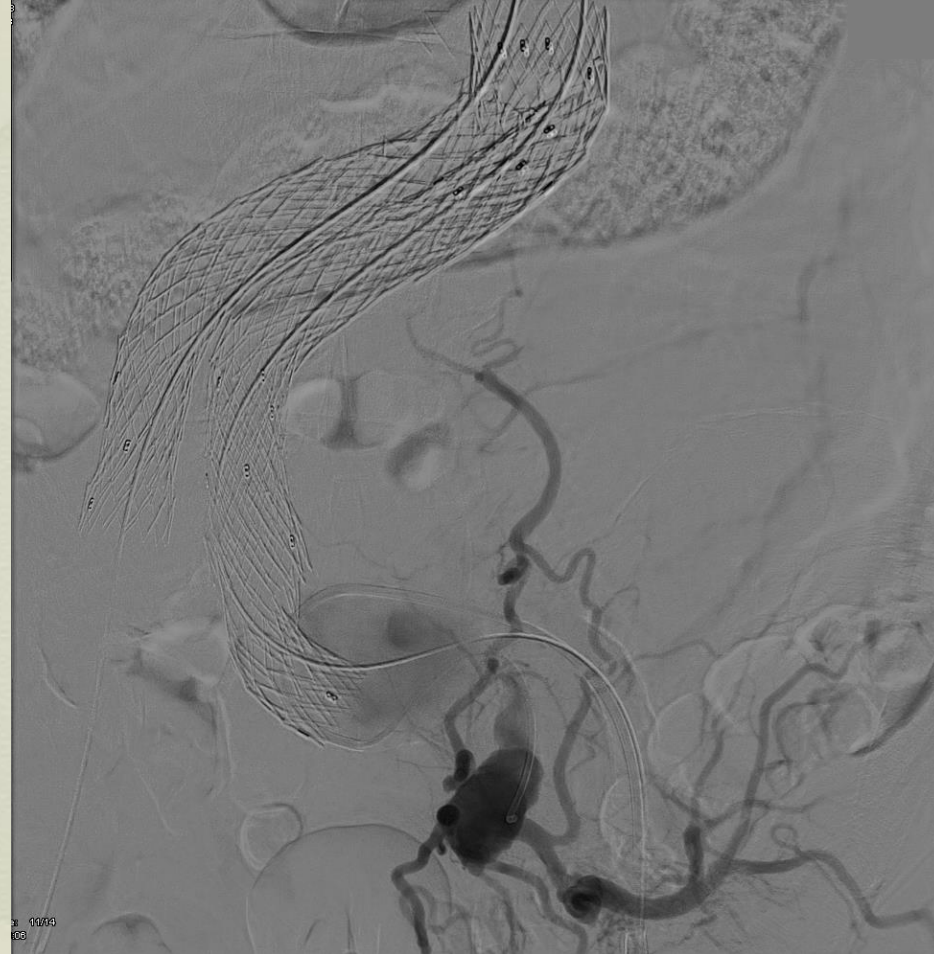
CO2 IMAGING DEMONSTRATING SLIPPED ENDOGRAFT



ANOTHER SLIPPED EVAR; IF CO2 IS NOT ADEQUATE USE A CONFIRMATORY IC RUN



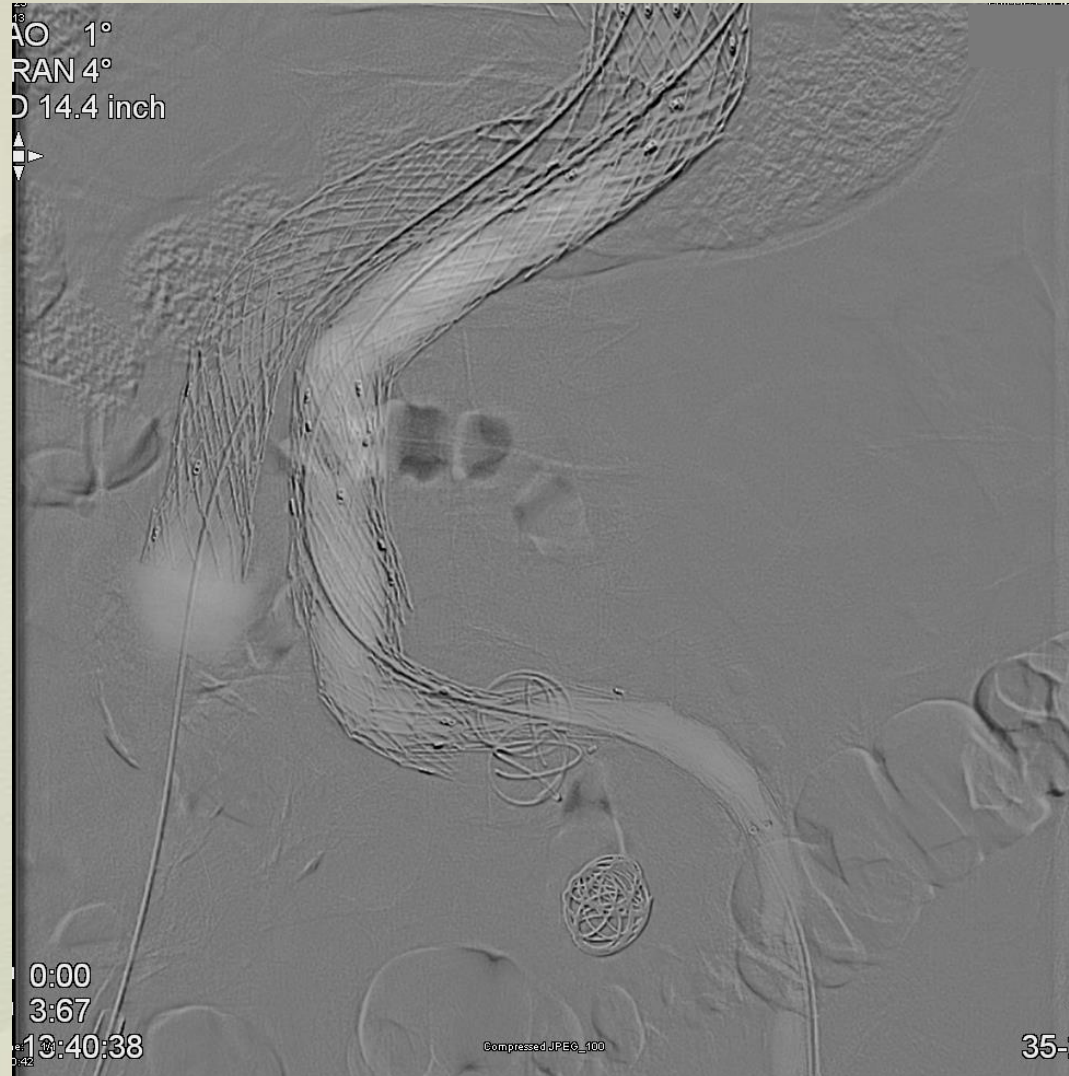
DILUTE IODINATED CONTRAST IMAGE TO BETTER DELINEATE HYPOGASTRIC ANEURYSM



CO2 USED TO CONFIRM ADEQUATE EMBOLIZATION AND PLAN EXTENSION



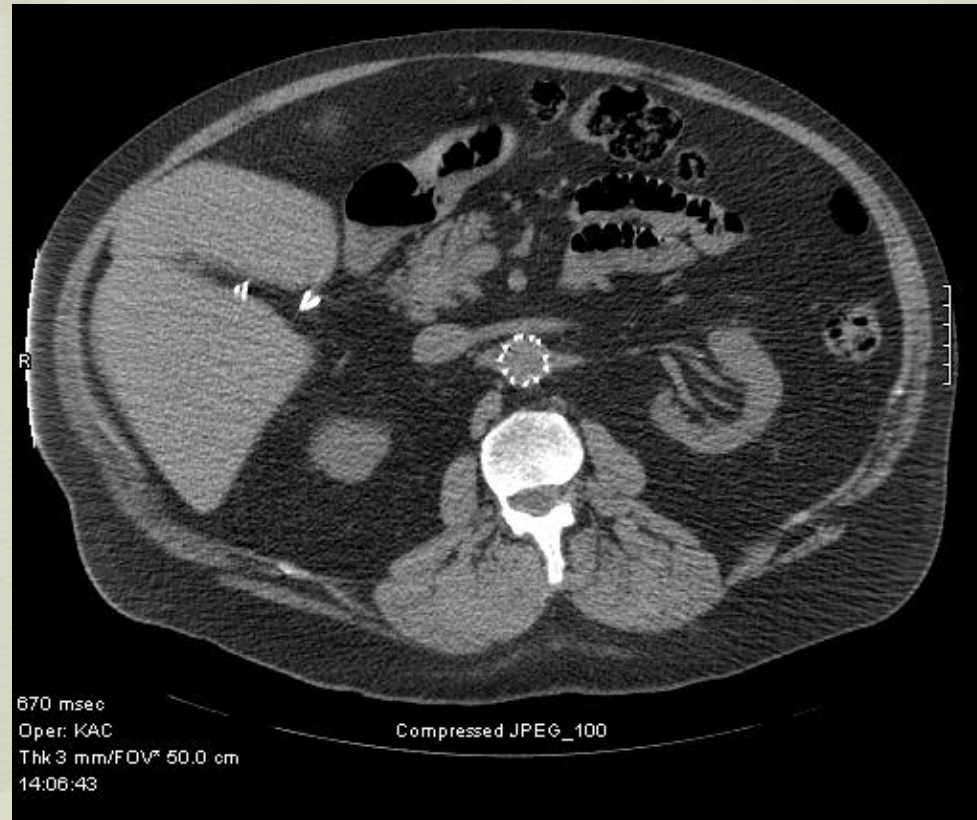
CO2 USED FOR LEFT LIMB COMPLETION STUDY



WHAT IS THE STATE OF THE ART?

EVAR IN PATIENTS WITH RENAL IMPAIRMENT OR SERIOUS IODINATED
CONTRAST ALLERGY

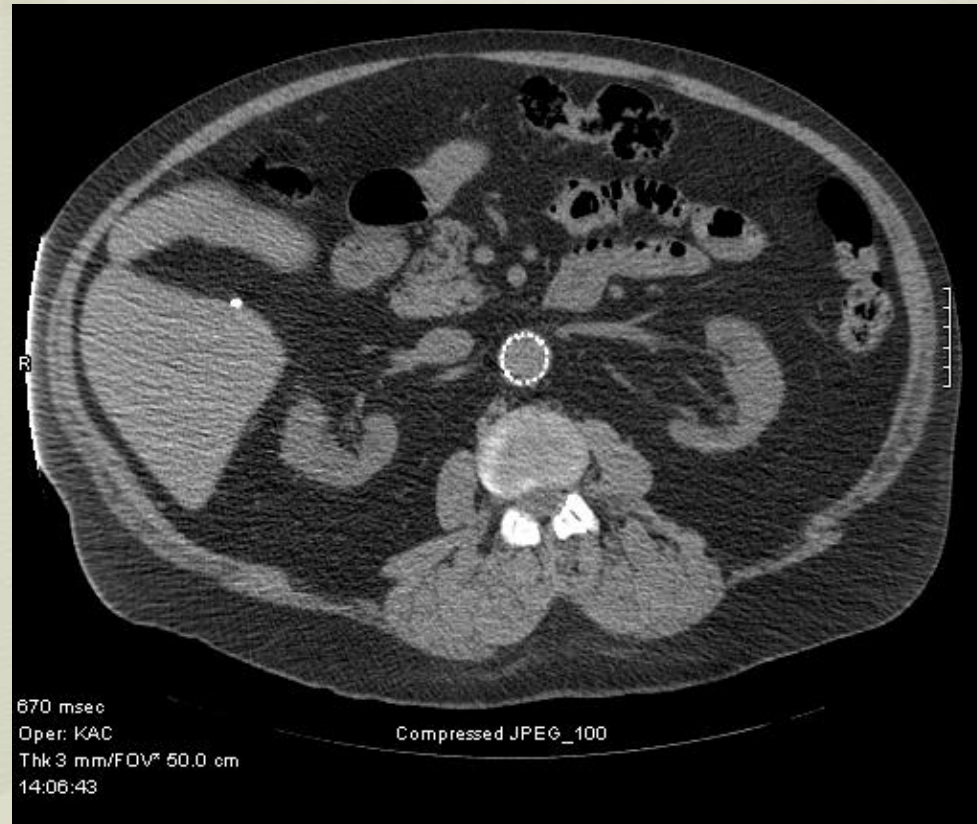
NON-CONTRAST CT SHOWS RENAL ARTERIES



MINIMIZING CONTRAST IN AT RISK PATIENTS FOR FOLLOW UP AFTER EVAR

- PATIENT STILL HAVE RENAL RISK FROM CONTRAST
- NOT FOLLOWING PATIENTS AFTER EVAR PLACES THE PATIENT AT HIGH RISK FOR PREVENTABLE COMPLICATIONS.
- NON-CONTRAST CT SCANS PAIRED WITH DUPLEX SCANNING USED IN THIS GROUP.
- LOOK FOR SAC GROWTH, ILIAC ANEURYSM GROWTH, AND DUPLEX FOR SHOWING ENDO-LEAKS

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 CO₂ IMAGING

- AWAKE OR ASLEEP PATIENT
- MINIMIZE BOWEL GAS
- CO₂ 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 IN CASE IODINATED CONTRAST IS NEEDED AS AN ADJUNCTIVE AGENT.
- USE SMALL AMOUNT OF IODINATED CONTRAST IF NEEDED.
- HELP SAVE PATIENTS FROM RENAL FAILURE.

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