ENDOLEAK FOLLOW-UP AND TRUE SAC EVOLUTION

2020

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FUNDAMENTAL GOAL OF AAA REPAIR

• by either surgical or endovascular means
  → to reduce the risks for aneurysm rupture and death...

HOWEVER...

UK EVAR trial collaborators NEJM 2010
“EVAR was associated with increased rates of graft-related complications and reinterventions”

UK EVAR trial collaborators Lancet 2016
More than 8 years after AAA repair, ruptures were still occurring in EVAR trial participants.

Fewer deaths vs open repair in the first 30 days but this advantage is lost after 1 to 5 years, largely owing to later graft failure.
ETIOLOGIES OF AAA RUPTURE AFTER EVAR

- Patient Factors:
  - Short neck
  - Angulation
  - Thrombus
  - Tortuosity
  - Occlusive disease
  - Progression of disease

- Physician Factors:
  - Poor device selection
  - Lack of judgment, knowledge, or skill
  - Other interest (e.g., financial, ego bias, etc.)

- Device Factors:
  - Lack of fixation
  - Integrity issues

- Evolve to:
  - + Failure of routine postoperative AAA surveillance

Endoleaks → Device Migration → Progression of Aortic Disease

White: EL = « Persistent perfusion of aneurysmal sac after EVAR »
- Primary EL < 30 days
- Secondary/Late EL > 90 days

Courtesy of Oderich et al.
WHAT DO WE KNOW ABOUT ELS?

▪ Most common failure mode of endovascular repair
  ▪ Early EL → 46% aneurysm-related morbidity at 5 years*

▪ Represents 40% of reinterventions after EVAR
  ▪ 57% of the open conversions after EVAR**
    ▪ 15% for ruptures
    ▪ Significant mortality: up to 25%

▪ Risk of rupture, increased in case of:
  ▪ Secondary/Persistent EL
  ▪ Aneurysmal diameter increase (> 5-10%)

Late rupture following EVAR

Monocentric, retrospective, observational study in our unit between 2009 and 2016
Incidence: 16.2% → 16 rEVAR over 99 rAAA

5 pts initially treated in our centre

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<td>rEVAR</td>
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<td>2</td>
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<td>6</td>
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<td>12,5</td>
<td>21</td>
<td>14,3</td>
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Mean delay: 49.5 m

37.5 % unfit for index EVAR (in IFU)
Late rupture following EVAR

Causes: an endoleak was always present

Associated factors:
- short (<15 mm) or angulated (>60°) neck
- aneurysmal progression
- infection

Mean time since last control: 23.6m

Shrinkage in 31%

In-hospital mortality: 43.7%
SURVEILLANCE NEEDS TO BE CONTINUOUS...AND AGGRESSIVE

All EL need to be searched and detected...
Especially the major one (I and III)

And all aneurysmal sac need to be followed carefully
With the good tools...
IMAGING ASSESSMENT OF ELs

HOW?

- CTA +++
- US
  - Color-Duplex US (CDUS)
  - Contrast-Enhanced US (CEUS)
- MRA

Aneurysm sac size (max $\Theta$) and Volume measurements are compared with measurements from prior imaging.
CTA

current modality of choice

- triple-phase approach with bolus tracking
  - pre-contrast phase
  - arterial phase → Type I and III ELs
  - delayed phase (2 to 5 min) → Type II ELs

- Endoleaks: contrast accumulation within the excluded aneurysm sac
  - Early contrast detection during arterial phase = high-flow EL
  - if there is aneurysm sac expansion → urgent attention is required
  - Late contrast detection during delayed images = low-flow EL

- Sensitivity 83% / Specificity 100% for EL detection*
  - wide availability
  - high spatial resolution
  - high diagnostic accuracy


- cumulative radiation burden
- repeated administration of nephrotoxic contrast agent
- financial burden

Recently, radiation reduction and contrast reduction protocols have been developed**
CDUS AND CEUS

- Able to visualize and evaluate blood flow in a real-time pattern
  - hemodynamic information
  - High flow EL >100 cm/s
  - Low flow EL <80 cm/s

- Ultrasonographic contrast agents = microbubbles (Sonovue ++)
  - CEUS is now regarded as a valuable complementary ultrasonographic technique based on Society guidelines***
  - ELs = complex dynamic phenomenon → ability of CEUS to accurately classify endoleaks ***
  - Especially helpfull with low-flow ELs

- CDUS Sensitivity 33-86% / Specificity 63-93% for EL detection****
- CEUS Sensitivity 100% / Specificity 65%*****

- Cost-effective
- High temporal resolution
- No nephrotoxicity
- No ionizing radiation

- Operator dependant
- Specialized equipment
- Better with low body mass index
- Suboptimal due to bowel gas
- Lack of sensitivity & specificity vs CTA

MRA

- Gadolinium contrast
- Ability to analyze hemodynamics with techniques like computational fluid dynamics and 4D phase contrast
- Particularly effective for Type II ELs and endotensions

- Sensitivity 96% / Specificity 100% for EL detection*
  - Does this increased likelihood of detecting ELs translates into superior outcomes ??

MR compatible endograft
- MR contraindications: claustrophobia, presence of other ferromagnetic devices such as pacemakers, advanced kidney disease
- Extra costs
- Lack of availability
- Expertise required
- Scan duration
- Susceptibility of artifacts depending on endograft
- Does not allow for direct visualization of the endograft: device integrity ??

IMAGING ASSESSMENT OF ELs

WHEN?

1st month after EVAR
CTA or CDUS (Level 1B)

No EL or sac enlargement

- Repeat imaging in 12 months
  CTA or CDUS (Level 1B)

  No EL or sac enlargement
  
  - Annual surveillance
    CDUS preferred
    If not feasible: CTA (Level 2C)

  New EL
  
  - Evaluation for a Type I or III EL by CTA
    (Level 2C)

  + Non Contrast-enhanced CT of entire aorta
    every 5 years (Level 2C)

Type II EL

- Repeat imaging in 6 months
  CTA or CDUS (Level 2B)

  Type II EL with sac shrinkage
  
  Or stable
  
  - CDUS for continued surveillance at 6 months
    intervals for 24 months
    then annually thereafter
    (Level 2C)

  New EL

- Evaluation for a Type I or III EL by CTA
  (Level 2C)
NEXT FUTURE: ARTIFICIAL INTELLIGENCE FOR FU

Software under development with specific algorithms that detect and calculate AUTOMATICALLY the CL, measurements (lengths, distances, separations…) and VOLUMES (global, inner lumen, wall, calcifications…)

www.nurea-soft.com
NEXT FUTURE: ARTIFICIAL INTELLIGENCE FOR FU
TAKE HOME MESSAGE

• Delayed AAA rupture following EVAR is growing

• It is associated with high postoperative mortality

• Respect of IFU and strict follow-up are mandatory to avoid these complications

• CTA remains the current modality of choice
  • Semi-automated and fully-automated algorithms are on their way
  • Follow-up intervals have been reviewed by recent guidelines to limit nephrotoxicity and radiation exposure while preserving sufficient surveillance
THANK YOU FOR YOUR ATTENTION
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