Radiation to operators during EVAR can cause DNA damage: What is the significance and what can be done to lessen it

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Representative exposures and its significance

<table>
<thead>
<tr>
<th>Type of exposure</th>
<th>Dose/Dose rate</th>
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</thead>
<tbody>
<tr>
<td>Medical diagnostics</td>
<td>0.01-25mSv</td>
</tr>
<tr>
<td>Dose limit for radiation worker</td>
<td>20mSv/year</td>
</tr>
<tr>
<td>Background radiation</td>
<td>1-10mSv/year</td>
</tr>
<tr>
<td>Complex endovascular case</td>
<td>50uSv</td>
</tr>
</tbody>
</table>

- 100mSv: Raised solid cancers and leukaemia risk
- Dose response below 100mSv?
- Individual radiation sensitivity?

Richardson et al. BMJ 2015
Leureud et al. Lancet Haematol 2017

The need for better epidemiological studies

- Stringent study design
- Well defined population
- Adequate sample size
- Control for confounding factors
- Rigorous follow up
- HIGH QUALITY DOSIMETRY

2008-2018: Dosimetry ESTIMATE

Total vascular cases: 1071

Estimated total dose
- 20uSv/case: 21mSv
- 40uSv/case: 42mSv
- 60uSv/case: 64mSv

Note: Excludes GI cases (gastrostomies, balloon dilations, stents insertions, PTCs), nephrostomies-ureteric stents, bleed/other embolisations, tunnelled lines, dialysis access, IVC filters

Low-dose or low-dose-rate ionizing radiation–induced bioeffects in animal models
Feng Ru Tien; Wendy Keong Leke and Bee Cheong Khoob

- Increased incidence of lung tumours
- DNA damage
- Shortened life span
- Risk synergic with other toxic agents (e.g. tobacco smoke)

Feng et al. J Radiation Research 2017
Operators: Evidence of DNA damage during EVAR

Markers of chronic exposure:
- Dicentric/Acentric chromosomal fragments

Markers of chronic exposure: Micronuclei

Current methods laborious
- Large number of cells
- Next gen/high throughput sequencing

What can I do in the meantime?

ALARA

Pro-inflammatory profile:
- ROS
- TGFβ
- IL-6
- TNF
- IL-8
Antioxidants?

- Cancer staging: 99mTc MDP bone scans
- Anti-oxidant formulation:
  - 1.2g N-acetylcysteine,
  - 600mg liposacids,
  - 30mg beta-carotene
- Reduced DNA damage (gamma H2AX)

- 0.25 Gy → HUVECs in vitro
- Anti-oxidant formulation:
  - Resveratrol (45%), Extramel (2.15%),
  - Seleno-l-methionine (2%), Curcuma longa (42%), reduced L-glutathione (6%),
  - and vitamin C (2.4%)
- Reduced ROS
- Reduced DNA damage (gamma H2AX)

Summary

- We live in a world of ever increasing radiation exposures
- Health effects of occupational exposure unknown
- Better radiation epidemiology needed
- Biological and physical dosimetry
- Assume all radiation is dangerous
- Insist on maximal protection