Session 3
Radiation effects and health risks from radiation exposure at the workplace
Contributed papers

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Summary of contributed papers

- Two contributed papers from Iran and Egypt

1. **Occupational Radiation Exposure, DNA Damage and Genetic Polymorphisms in DNA Repair Genes**
   (F. Zakeri et al)

2. **Endothelial Progenitor Cells in Peripheral Blood of Cardiac Catheterization Personnel**
   (S. Korraa et al.)
These papers have two common features

Study population:
- health workers exposed during fluoroscopy procedures

One of the end points:
- frequency of micronucleus (MN) in peripheral lymphocytes (cytokinesis-block micronucleus assay)
The cytokinesis-block MN assay in peripheral blood lymphocytes is a validated technique of biological dosimetry (e.g. accidental exposures). It has been also used to evaluate levels of DNA damage in workers occupationally exposed to radiation.

- In addition to radiation, other genotoxic agents (e.g. tobacco) can increase the MN frequency.
- Baseline MN frequency depends strongly on age and gender.
Occupational Radiation Exposure, DNA Damage and Genetic Polymorphisms in DNA Repair Genes

F. Zakeri, MR Farshidpour, MR Rajabpour, MJ Ahmadpour, F. Mianji

Objective: to determine the relationship between genetic polymorphisms in genes coding DNA repair enzymes and the levels of DNA damage in interventional cardiology staff
# Study population

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Exposed group&lt;sup&gt;(a)&lt;/sup&gt;</th>
<th>Control group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Males</td>
<td>59</td>
<td>38</td>
</tr>
<tr>
<td>Females</td>
<td>31</td>
<td>22</td>
</tr>
<tr>
<td>Total</td>
<td>90</td>
<td>60</td>
</tr>
<tr>
<td>Mean age (years +/- SD)</td>
<td>41.5 +/- 7.6</td>
<td>41.4 +/- 9.1</td>
</tr>
<tr>
<td>Mean last year exposure</td>
<td>3.5 +/- 2.7 mSv</td>
<td>-</td>
</tr>
<tr>
<td>Mean last 5 years exposure</td>
<td>11.2 +/- 10.5 mSv</td>
<td>-</td>
</tr>
<tr>
<td>Mean years of employment</td>
<td>9.5 +/- 6.7</td>
<td>-</td>
</tr>
</tbody>
</table>

<sup>(a)</sup> *interventional cardiologists, technicians and nurses*
End points in peripheral blood lymphocytes

- Frequency of micronucleus
  by cytokinesis-block micronucleus test in binucleated cells

- Single nucleotide polymorphisms (SNPs)
  by polymerase chain reaction combined with restriction fragment length polymorphism (PCR-RFLP genotyping assay)

In genes coding DNA repair enzymes:
1. XRCC1
2. OGG1
3. APE1
4. XRCC3
5. XPG
Results

- MN frequency significantly higher in:
  - exposed group vs. control group
  - within exposed group >3mSv/y vs. ≤3mSv/y
  - within exposed group >10 years vs. ≤10 years of exposure
  - exposed group carrying SNPS in the genes XRCC3 and XPG
  - control group carrying SNPs in the gene OGG1
Authors' conclusion

- Occupational exposure to IR in interventional cardiologists, technicians and nurses is associated to increased DNA damage (expressed as higher MN frequency).

- DNA damage was higher in individuals carrying genetic polymorphisms in DNA repair enzymes (SNPs), suggesting that this might represent a particularly vulnerable population (mutagenic and cancer risk).

- The relationship between MN and SNPs in genes involved in DNA repair may contribute to evaluate susceptibility to ionizing radiation in individuals occupationally exposed.
Endothelial Progenitor Cells in Peripheral Blood of Cardiac Catheterization Personnel

S. Korraa\textsuperscript{a}, MS Tawfik\textsuperscript{a}, A Zaher\textsuperscript{b}, M Maher\textsuperscript{c}

\textsuperscript{a) Department of Radiation Health, National Centre for Radiation Research and Technology, Cairo, Egypt

\textsuperscript{b) National Health Institute, Cairo, Egypt

\textsuperscript{c) Faculty of Science, Suez Canal University, Cairo, Egypt

\textbf{Objective:} to evaluate the level of circulating endothelial progenitor cells and its correlation with DNA damage in staff exposed during fluoroscopy cardiac procedures.
# Study population

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Exposed group&lt;sup&gt;(a)&lt;/sup&gt;</th>
<th>Control group</th>
</tr>
</thead>
<tbody>
<tr>
<td>n Total</td>
<td>70</td>
<td>40</td>
</tr>
<tr>
<td>Smokers</td>
<td>34</td>
<td>-</td>
</tr>
<tr>
<td>Non-smokers</td>
<td>46</td>
<td>40</td>
</tr>
<tr>
<td>Mean age (years +/- SD)</td>
<td>42.8 +/- 5.2</td>
<td>42 +/- 4.8</td>
</tr>
<tr>
<td>Annual dose (range)</td>
<td>2.16 – 8.44 mSv/year</td>
<td>-</td>
</tr>
</tbody>
</table>

<sup>(a)</sup> *Staff involved in fluoroscopy-guided cardiac catheterization in 3 hospitals in Cairo, Egypt*
Biological end points

- Frequency of micronucleus by cytokinesis-block micronucleus test in binucleated cells

- Number of Endothelial Progenitor Cells (EPCs) in peripheral blood (PB) by flow cytometry with monoclonal antibodies for CD133, CD34 and kinase domain receptors (KDR)

- Plasma levels of stromal growth factor (SDF-1) using ELISA assay
Results

- The staff involved in fluoroscopy-guided cardiac catheterization (CC) presented:
  - Significantly higher micronucleus (MN) frequency
  - Significantly higher number of Endothelial Progenitor Cells (EPCs) in peripheral blood
  - Significantly higher plasma levels of stromal growth factor (SDF-1)

- Smoker CC staff exhibited higher MN frequency and SDF-1 and lower levels of EPCs than non-smokers
Author's conclusion

- Staff involved in fluoroscopy-guided cardiac catheterization present and increased MN frequency, which is higher in smokers vs. non-smokers.

- Circulating EPCs numbers and SDF-1 plasma levels, which are markers of endothelial activation/damage, are significantly increased in the radiation exposed group.

- The dual effect of IR and smoking (i.e. additive effect on inducing SDF-1 expression as other DNA damaging agents, with an opposite effect on the number of EPCs in peripheral blood) is interpreted as a regenerative process decreased by smoking.

- Further studies are needed to elucidate the role of EPCs as a potential marker of radiation exposure.