Tomoscintigraphic comparison of lung deposition with a vibrating-mesh and a jet nebulizer

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Introduction and Aim

- Vibrating-mesh nebulizers ensure the best lung deposition output. However, jet nebulizers remain the mostly used category of nebulizers.
- A specific inhalation chamber combined to a vibrating-mesh nebulizer (VN-C) was recently developed to optimize aerosol delivery to the lungs. An in vitro study demonstrated the higher aerosol delivery with this vibrating-mesh nebulizer connected to its specific inhalation chamber as compared to a standard jet nebulizer (JN).
- Recent international recommendations were elaborated to standardize the analysis of pulmonary regional deposition of a radiolabeled aerosol using single photon emission tomography (SPECT).
- The aim of this study was to compare in vivo the pulmonary aerosol deposition obtained with a VN-C and a JN.

Methods

Nebulization

- Two nebulizers filled with technetium-99m labelled diethylaminoethanol (99mTc-DTPA, 2mC/4mL) were randomly tested in cross-over on 6 healthy male subjects:
  - Vibrating-mesh nebulizer combined to a specific inhalation chamber (VN-C)
  - Jet nebulizer connected with a reservoir tube (JN)

Radionuclide imaging for deposition analysis

- Distribution of inhaled 99mTc-DTPA into the lower airways was assessed by single photon emission computed tomography (SPECT) combined with a low dose CT scan using a home-made plug-in to ImageJ software (Rasband W, http://imagej.nih.gov/ij/, 1997-2014, Bethesda, MD) based on international recommendations.

Results

Higher 99mTc-DTPA deposition in the lower airways with VN-C but similar distribution and penetration in both lungs

<table>
<thead>
<tr>
<th>Outcome (%)</th>
<th>VN-C</th>
<th>JN</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pulmonary deposition</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Both lungs</td>
<td>34 ± 6</td>
<td>52 ± 1.1</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Right lung</td>
<td>17.9 ± 2.8</td>
<td>2.7 ± 0.7</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Left lung</td>
<td>16.3 ± 3.4</td>
<td>2.5 ± 0.5</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>3D Normalized O/I ratio</td>
<td>0.48 ± 0.19</td>
<td>0.48 ± 0.21</td>
<td>0.982</td>
</tr>
<tr>
<td>Tracheal deposition</td>
<td>5.0 ± 4.3</td>
<td>0.3 ± 0.4</td>
<td>0.035</td>
</tr>
</tbody>
</table>

Radionuclide imaging for deposition analysis

- Illustration of shell decomposition of SPECT images for both nebulizers (Right, VN-C and Left, JN) on the same subject, with the same level of brightness

Conclusion

- This in vivo study demonstrated that a vibrating-mesh nebulizer equipped with its specific inhalation chamber highly increases aerosol delivery to the lungs in healthy male subjects as compared to a jet nebulizer.
- Further studies in selected patients groups are needed to assess the clinical benefit of this increased lung deposition output.

- In the in vitro study demonstrated the higher aerosol delivery with this vibrating-mesh nebulizer connected to its specific inhalation chamber as compared to a standard jet nebulizer (JN).
- Recent international recommendations were elaborated to standardize the analysis of pulmonary regional deposition of a radiolabeled aerosol using single photon emission tomography (SPECT).

References