Background: The evaluation of leakage plays a pivotal role in dental research as most oral pathologies develop at plaque retentive niches due to the accumulation of bacteria and their by-products. The complex implant-abutment interface represents a typical example thereof. Thus, implants should be favorably fabricated and installed with tight seal to prevent or limit pathological inflammatory changes at the adjacent tissues.

Aim: To develop a customized and standardized measurement device allowing repetitive non-destructive evaluation of implant leakage.

Materials and methods: An environmentally controlled device was developed, which consists of two chambers allowing gas pressure change measurement and fluid volume infiltration at 35 °C (Figure 1). To maintain the static chamber, the set-up was designed in an isolation room (Figure 2). Three implants systems were tested in an N=20 per group: Nobel Biocare (NB), Astra Tech (AT) and Biomet 3i (Bi3). Four implants in each group served as negative controls.

The implants were mounted in PVC custom made disks with a diameter of 15 mm, which served as a tight separating holder between the two inner chambers (Figure 3, A). The upper chamber was filled with 2.5 ml physiologic saline and pressurized with N2 gas at 0.15 MPa in 30 min. The lower chamber was kept pressurized at 170 hPa containing no liquid, resulting in a total pressure difference of 1030 hPa. The pressure difference change over time was measured as primary outcome variable over 40 minutes to establish the baseline leakage through this set-up. To ensure a temperature equilibrium, the whole 20 minutes were considered relevant to determine the rate of leakage expressed as pressure loss over time. In addition, the infiltrated saline volume into the lower chamber was measured over the whole period. The samples were then removed, a small hole was drilled at the implant apex taking care not to damage the internal threads and the abutment was attached to the implant with the screw tightened according to the manufacturer’s instructions. The screw access was sealed with a composite build-up before the sample was mounted again for further leakage evaluation (Figure 3, D). The baseline slope and fluid leakage values were subtracted from the test values to determine the absolute gas and saline leakage rate. A Mann-Whitney test was used to compare the results and linear correlation between pressure and water. The p-value was set at 5%.

Results: Four samples of the AT and two of the NB group were excluded from further data analysis because they showed complete sealing even before the observation leakage was terminated. The rate of gas pressure change (hPa/min) was significantly different between all groups (Table 2). There was decreasing mean leakage values as follows: AT 0.85±0.71, NB 0.23±0.03 and Bi3 0.01±0.01 (p<0.00). The saline infiltration through the implant abutment interface correlated to the pressure change rates and accounted for 0.58±0.50 ml (AT), 0.12±0.20 ml (NB) and 0.0±0.3 ml (Bi3), respectively (Figure 4). The correlation coefficient was high (R=0.965).

Conclusion: Under the simulated conditions, the Bi3 showed the best sealing ability. The method has proven to be able to reliably detect small differences in gas and water leakage between different systems. These parameters were well correlating.


Acknowledgement: implant systems were obtained directly from each manufacturer utilizing funding through a research grant by Biomet 3i.

Announcement of interest conflict: The study design was conceived and executed independently, however the presenter’s PhD fellowship is supported by Biomet 3i.

Correspondence: Dr. Anas Al-Jadad Department of Preventive Dentistry, Periodontology and Cariology University of Zurich, Center for Dental Medicine Perlemattstrasse 11, CH 8032 Zurich, Switzerland Tel: +41 44 634 4265, Fax: +41 44 634 4308 E-mail: anas.al-jadad@zzm.uzh.ch

Table 1: Implant, Abutment and screw description

<table>
<thead>
<tr>
<th>Implant Type</th>
<th>Mean Slope Value</th>
<th>Infiltrated Saline Volume (ml)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Astra</td>
<td>0.85±0.71</td>
<td>0.06±0.50</td>
</tr>
<tr>
<td>Nobel Biocare</td>
<td>0.23±0.03</td>
<td>0.12±0.20</td>
</tr>
<tr>
<td>Biomet 3i</td>
<td>0.01±0.01</td>
<td>0.00±0.00</td>
</tr>
</tbody>
</table>

Table 2: Leakage indices

- Slope mean values (hPa/min)
- Perfusion fluid mean value (ml)

Figure 3: Split testing chamber
- A: Abutment; B: Implant; C: Isolation chamber; D: Testing split chamber

Figure 4: Leakage indices
- Slope mean values (hPa/min)
- Perfusion fluid mean value (ml)