Dental care before lung transplantation: are we being too rigorous?
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Abstract
Objective: Poor dental status is known to cause infections in severely sick and in elderly patients. In patients awaiting lung transplantation, rigorous dental treatment is a common prerequisite, although evidence-based data are lacking with regard to extent, necessity and effect on post-transplantation infectious status. Materials and Methods: In the present retrospective study, dental status (dental history (missing teeth, caries, tooth restorations and extractions, prevalence of periodontitis) and dental treatment prior transplantation) was assessed in 85 lung transplant candidates at the University Hospital of Freiburg, Germany and evaluated for infectious foci in the first 3 years following transplantation. Results: Forty-nine patients got transplanted in the observed timespan. Total tooth count differed significantly between chronic obstructive pulmonary disease (16 ± 9), pulmonary fibrosis (22 ± 7) or cystic fibrosis (30 ± 3) patients prior transplantation (P > 0.001). Periodontitis prevalence yielded no difference and was mainly not treated prior transplantation. No dental-related infectious focus could be diagnosed post-transplantation. However, 15% of post-transplantation infections were of unknown focus, and infection rate was increased in year 2 post-transplantation in patients without periodontitis. Conclusion: No clearly defined dental foci were registered following transplantation. This raises the question of whether current dental treatment in these highly compromised patients is too rigorous with regard to tooth extractions. However, no focus could be detected in 15% of the registered infections. Therefore, controversially, post-transplantation dental care could also be insufficient with regard to undertreated periodontitis.


Key words
COPD – dental care – infection – lung transplantation – periodontitis

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WW participated in performance of the research, writing of the paper, data analysis and research design.

Ethics
The study was approved by the Ethics Committee of the University Hospital of Freiburg and complies with the standards laid down in the Declaration of Helsinki.

Conflict of interest
The authors have stated explicitly that there are no conflicts of interest in connection with this article.
Introduction

Oral bacteria, poor oral hygiene and periodontitis appear to influence the incidence of pulmonary infections, especially episodes of nosocomial pneumonia in high-risk subjects (1–3). Poor dental status is associated with a higher risk of nosocomial pneumonia especially in elderly and intensive care unit (ICU) patients (2, 3). Furthermore, periodontal diseases are supposed to be associated with chronic obstructive pulmonary disease (COPD) and smoking history (2, 3) but no data exist for other pulmonary diseases.

Dental status assessment and treatment is considered in most transplantation centres to be a mandatory prerequisite for solid organ transplantation (4). According to current International Society for Heart & Lung Transplantation (ISHLT) guidelines (5), cardiac transplant patients require an annual dental examination prior to transplantation, even though there are no case–control studies providing evidence to support this; there is no such official recommendation for lung transplant recipients. Moreover, studies investigating the impact of dental status on lung transplantation outcome are non-existent.

Several case reports have described dental infectious foci in immunocompromised patients following solid organ transplantation (6–8), but so far, there is no long-term post-transplant data on dental infections. In a survey among US transplant centres about dental status, post-transplantation sepsis was attributed to dental foci in 27% of cases (9). However, other studies have shown that omission of pre-transplant dental care in heart-transplant patients does not result in increased post-transplant morbidity (10, 11).

The aims of this retrospective study were to assess (i) dental history (missing teeth, caries, tooth restorations and extractions, prevalence of periodontitis) in all patients awaiting lung transplantation, (ii) to specify the dental treatment that occurred prior to lung transplantation and (iii) to report on the origin and type of infections in the first 3 years following transplantation at the University Hospital of Freiburg from October 2002 until November 2009.

Materials and Methods

The study was approved by the Ethics Committee of the University Hospital of Freiburg and complies with the standards laid down in the Declaration of Helsinki in its latest form (12). The trial was registered at the German Clinical Trials Register (Trial registration number: DRKS00002482). Dental screening data, infection rates, focus and type of infections were assessed according to the available medical records from the hospital computer system. All patients attended regular visits to the specialized outpatient clinic for lung transplant recipients prior and post-transplantation. Visits were regularly scheduled in 3-month intervals or immediately as needed in the outpatient clinic or ward of the respiratory department. Dental post-transplantation infection was assumed when patients presented with dental symptoms (i.e. dental pain, tooth-tilting or development of dental caries) or conspicuous intraoral examinations during physical examinations at follow-up visits.

Data analysis was performed using SigmaPlot 11.2 (Systat Software Inc., San Jose, CA, USA). All normally distributed data are presented as mean ± standard deviation; non-normally distributed data are presented as median with interquartile ranges. The 95% confidence interval of the mean is given where appropriate. Group comparisons between two groups were performed using the paired or unpaired t-test (Mann–Whitney rank test) for normally (non-normally) distributed data. When comparing more than two groups, one-way ANOVA was performed using the F-test (Kruskal–Wallis one-way ANOVA on ranks) if data were normally (non-normally) distributed. The Pearson Product Moment Correlation was used for correlation analysis.

Results

Eighty-five patients were enrolled in the lung transplantation programme, 49 of whom underwent transplantation. Patients' details are given in Table 1. The mean age of patients with cystic fibrosis (CF) (26 years) was significantly different to that of patients with COPD (55 years) or pulmonary fibrosis (56 years) (all $P < 0.001$).

Pre-transplant dental status is presented in Table 2. Total mean tooth count in all patients was 22 teeth. The total number of teeth differed significantly between COPD patients, CF patients and fibrosis patients, respectively (all $P < 0.001$, Table 2). The prevalence of periodontitis in COPD and Fibrosis patients was 66% and 55%, respectively; the mean total prevalence in all patients was 57%. Although periodontitis treatment was recommended by the dentists prior to transplantation, it was only performed in two patients. There was no correlation between tooth vitality, total tooth count or tooth extractions in all patient groups (Table 2).

Infection rates following lung transplantation were evaluated for COPD, CF and Fibrosis patients
Table 1. Patient characteristics

<table>
<thead>
<tr>
<th></th>
<th>ß</th>
<th>ß</th>
<th>Age (years)</th>
<th>BMI (kg/m²)</th>
<th>FEV1 (% pred)</th>
<th>COPD</th>
<th>Fibrosis</th>
<th>CF</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>All</td>
<td>43</td>
<td>42</td>
<td>53* (47/58)</td>
<td>23 (5)</td>
<td>28* (18/43)†</td>
<td>35</td>
<td>31</td>
<td>8</td>
<td>11</td>
</tr>
<tr>
<td>Transplant</td>
<td>27</td>
<td>22</td>
<td>54* (46/60)</td>
<td>23 (5)</td>
<td>27* (18/45)‡</td>
<td>15</td>
<td>23</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>Waiting</td>
<td>16</td>
<td>20</td>
<td>53* (47/57)</td>
<td>23 (5)</td>
<td>28* (19/42)</td>
<td>20</td>
<td>8</td>
<td>3</td>
<td>5</td>
</tr>
</tbody>
</table>

Other patients include those awaiting transplantation because of pulmonary hypertension, alpha-1-antitrypsin deficiency, bronchiolitis or mixed collagenosis.

*Non-normally distributed data.
†n = 84.
‡n = 48.

n, total count; ß, men; ß, women; CF, cystic fibrosis; BMI, body mass index; FEV1, forced expiratory volume in 1 second; COPD, chronic obstructive pulmonary disease.

(Table 3); no significant difference in the relative yearly incidence of infections within the first 2 years post-transplantation could be detected between patient groups (Fig. 1). However, there was an increased rate of infection in the third post-transplantation year in CF patients when compared with COPD patients in the first year (P < 0.05). According to statistics, there were more pulmonary infections than urinary tract or any other types of infections such as ocular or cutaneous (both P < 0.05) (Fig. 2). No dental infections were registered. In general, there are more bacterial infections than fungal infections or those of unknown focus (P < 0.05). Notably, patients without periodontitis presented with an elevated infection rate in year 2 post-transplantation (3.5 ± 1.7) when compared with patients with periodontitis (median 1; 0/2) (P = 0.006).

Discussion

This is the first study to retrospectively assess the dental status in a mixed group of lung transplantation candidates in relation to post-transplantation infectious foci with the following main findings.

The mean total tooth count was significantly reduced in pre-transplantation COPD patients, compared with CF and Fibrosis patients, which could be attributed to the younger mean ages of the two latter groups. This observation is in line with previous data from pre-transplant COPD patients in a study by Leuckfeld et al. (13). There is no difference in the patients’ tooth count when compared with age-matched data from the 4th German Oral Health Survey of the general German population (14) (mean total tooth count 14.3 for the age group 65–74 years).

Table 2. Categorization of dental status in lung transplant recipients according to underlying disease

<table>
<thead>
<tr>
<th></th>
<th>Tooth count</th>
<th>Non-vital teeth</th>
<th>Caries</th>
<th>Extractions</th>
<th>No periodontitis</th>
<th>Localized periodontitis</th>
<th>Generalized periodontitis</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>n</td>
<td>n</td>
<td>n</td>
<td>% of patients</td>
<td>% of patients</td>
<td>% of patients</td>
</tr>
<tr>
<td>COPD</td>
<td>16 (8.7)</td>
<td>1 (0/2)*</td>
<td>0 (0/2)*</td>
<td>2 (0/5)*</td>
<td>33†</td>
<td>21†</td>
<td>45†</td>
</tr>
<tr>
<td>n = 35</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fibrosis</td>
<td>22 (7.1)</td>
<td>1 (0/2)*</td>
<td>0 (0/1)*</td>
<td>0 (0/3)*</td>
<td>43‡</td>
<td>20‡</td>
<td>36‡</td>
</tr>
<tr>
<td>n = 31</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CF</td>
<td>30 (3.3)</td>
<td>0 (0/1)*</td>
<td>3 (0/5)*</td>
<td>1 (0/3)*</td>
<td>100§</td>
<td>0§</td>
<td>0§</td>
</tr>
<tr>
<td>n = 8</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Others</td>
<td>19.6 (9.5)</td>
<td>2 (1/4)*</td>
<td>0 (0/2)*</td>
<td>2 (0/3)*</td>
<td>33¶</td>
<td>44¶</td>
<td>22¶</td>
</tr>
<tr>
<td>n = 11</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

Other patients included those awaiting transplantation because of pulmonary hypertension, alpha-1-antitrypsin deficiency, bronchiolitis or mixed collagenosis.

*Non-normally distributed data.
†n = 33.
‡n = 27.
§n = 7.
¶n = 9.
n, total count; CF, cystic fibrosis; COPD, chronic obstructive pulmonary disease.
Leuckfeld et al. diagnosed periodontitis radiographically in 43.8% of pre-transplant COPD patients compared with 7.3% of other lung transplant candidates (13); these data are not reflected in our findings in COPD patients (in total 66%) and other lung transplant candidates (i.e. 56% in total for Fibrosis) (Table 2). The discrepancy between the previous and current data may be because of methodology, because we used clinical examination techniques such as probing pocket depth. In addition, there is a close link between smoking behaviour, COPD and periodontitis (3, 15–18). However, periodontitis is a common problem in elderly people [mean prevalence 88% in the age group 65–74 according to (14)] and appears not to be a sole problem to patients with advanced COPD.

Bacteria colonizing the teeth or the periodontium – which is common to periodontitis – appear to serve as a reservoir for recurrent pulmonary infections in immunocompromised and ICU patients (1, 2, 19–22). The prevalence of upper airway and pulmonary infections in our patient group corresponds well to published data (23, 24) and is likely attributed to continuous exposure of the transplanted organ to microbes, denervation of the allograft with inhibition of the cough reflex and impaired mucociliary clearance (23) even though periodontitis mainly remained untreated prior to transplantation.

In the current data analysis, no definitive dental focus could be determined post-transplantation. Our data correspond to previous data in relation to the type of infection (24, 25); however, 15% of the infections remained unclear regarding their focus. In a short-term follow-up study, Velich et al. reported a 35% incidence of dental foci in 55 patients at 10 months post-transplantation, with one case of dental focus triggering impairment of health (26). However, the 15% incidence of unknown infection remains to be elucidated; therefore, post-transplant dental assess-

<table>
<thead>
<tr>
<th>Infections/year in the transplantation cohort in the follow-up period</th>
<th>Infections/</th>
<th>Infections/</th>
<th>Infections/</th>
</tr>
</thead>
<tbody>
<tr>
<td>year 1</td>
<td>year 2</td>
<td>year 3</td>
<td></td>
</tr>
<tr>
<td>n</td>
<td>n</td>
<td>n</td>
<td></td>
</tr>
<tr>
<td>Patient numbers</td>
<td>49</td>
<td>227</td>
<td>18</td>
</tr>
<tr>
<td>Infections (absolute)</td>
<td>152</td>
<td>61</td>
<td>45</td>
</tr>
<tr>
<td>Relative infections/year</td>
<td>2* (0.3/4.7)</td>
<td>2* (0/3.8)</td>
<td>0* (0/4)</td>
</tr>
<tr>
<td>COPD</td>
<td>2* (0.3/4.7)</td>
<td>2* (0/3)</td>
<td>0* (0/0)</td>
</tr>
<tr>
<td>n = 15</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fibrosis</td>
<td>2* (0/4.4)</td>
<td>1.4* (0/2.6)</td>
<td>0* (0/6)</td>
</tr>
<tr>
<td>n = 23</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CF</td>
<td>4.6 (3.9)</td>
<td>3.5 (1.7)</td>
<td>5 (3.5)</td>
</tr>
<tr>
<td>n = 5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Others</td>
<td>5.3 (6.4)</td>
<td>3.5 (3.5)</td>
<td>3.4 (4.8)</td>
</tr>
<tr>
<td>n = 6</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

*Non-normally distributed data.
†n = 11.
‡n = 10.
§n = 6.
¶n = 4.
**n = 2.

n, total count; CF, cystic fibrosis; COPD, chronic obstructive pulmonary disease.

Figure 1. Post-transplantation infections per patient per year. COPD, chronic obstructive pulmonary disease; CF, cystic fibrosis.
ment should be considered in repeated cases of respiratory or unknown infection. Controversially, in 61 heart-transplant patients without pre-transplant dental treatment, no dental focus could be detected in the post-transplant follow-up period (10). Interestingly, an elevated infection rate was observed in those patients without periodontitis in year 2 post-transplantation. It could be speculated that the elevated rate of infection in CF patients is because of previous colonization of upper airways with multidrug-resistant bacteria (27); however, these data conflict with other studies, showing a lack of increase in infection rates in CF patients (24). Yet, sinonasal colonization has not been conclusively evaluated in our patients. However, other data strongly suggest that post-transplantation colonization is present in these patients (27, 28), and periodontal pockets provide a shelter for anaerobic bacteria entering the sputum in CF patients (29) which make them therefore susceptible for recurrent infections triggered by the oronasal tract.

In conclusion, although rigorous dental treatment regarding tooth extraction was performed in patients awaiting lung transplantation, subsequent treatment of periodontitis was otherwise scarce. No clearly defined dental foci were registered in the 3-year period following transplantation. However, no focus could be evaluated in 15% of the registered infections; this may be because of poorly treated periodontitis, albeit infection rate was increased in year 2 post-transplantation in patients without periodontitis. Further randomized studies are needed to assess the need and extent of dental treatment in lung-transplant recipients, with regard to post-transplantation infections.

References
