Perioperative changes in oral bacteria number in patients undergoing cardiac valve surgery

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Abstract: Perioperative oral care can reduce the risk of postoperative infections. This study examined 1) changes in oral bacteria counts during the perioperative period and 2) differences in bacteria counts in patients with or without endotracheal intubation. 47 patients who visited our hospital dental clinic prior to cardiac valve surgery were prospectively recruited. The number of bacteria on the tongue, tooth surface, and buccal vestibule was measured on the day before and 1, 4, and 7 days after surgery. Oral bacteria counts were statistically compared among time points and between intubation and extubation statuses. The oral bacteria counts on the tooth surface and buccal vestibule significantly increased from the day before surgery to 1 day after surgery, and then decreased from 1 to 4 days after surgery. On the day after surgery, the bacteria counts on the tooth surface and buccal vestibule were significantly higher in the intubated compared with the extubated group. Our findings suggest that the oral bacteria count is elevated just after surgery, especially if the patient has endotracheal intubation, which may increase the risk of aspiration pneumonia. These results highlight the importance of perioperative oral care to prevent postoperative pneumonia.

Keywords: oral bacteria, perioperative oral hygiene management, intubation, ventilator-associated pneumonia, oral health care

Introduction

As increased oral bacteria is one of the major risk factors for respiratory infections [1], systematic perioperative oral hygiene care by patients themselves or by dental professionals are recommended to reduce the risk of postoperative pneumonia following oral cancer surgery and thoracic surgery [2,3]. Periodontal disease and untreated decayed teeth are also risk factors for postoperative respiratory infection [4]. Pathogenic oral bacteria can be observed in heart valves and atheromatous plaques [5-7]. For patients at risk of infectious endocarditis (IE), such as those with acquired valvular disease or receiving an artificial heart valve replacement, dental check-ups and treatment are recommended to prevent odontogenic infection, according to IE prevention guidelines [8]. Therefore, dental intervention prior to surgery is important as it has the potential to reduce the risk of postoperative circulatory and respiratory infections in patients receiving heart valve surgery [8,9].

The incidence of pneumonia is increased in patients receiving mechanical ventilation [10]. Our previous study demonstrated that the oral bacteria count significantly decreased after removal of the endotracheal tube (i.e., extubation), suggesting the presence of an elevated number of oral bacteria during intubation [11]. The biofilm that forms the endotracheal tube used during intubation is reportedly associated with the onset of ventilator-associated pneumonia (VAP) [12]. To reduce VAP risk, oral hygiene care is important to halt the passage of pathogenic bacteria into the lower airway [13-16]. An extended intubation period can also increase the risk of oropharyngeal dysphagia after endotracheal tube removal [17,18]. Dysphagia is strongly related to malnutrition in hospitalized patients and may also contribute to infections.

Although recent reports have described the importance of perioperative oral hygiene management, quantitative changes in oral bacteria remain unclear. One study reported an increase in oral bacteria in gastrointestinal cancer patients submitted to open surgery [19], but little is known about oral bacteria count changes in patients submitted to heart surgery, who have a greater likelihood of extended endotracheal intubation. In this study, 1) changes in oral bacteria count during the perioperative period in patients receiving heart valve surgery and 2) differences in bacteria counts between such patients with endotracheal intubation and after extubation were examined.

Materials and Methods

Participants

In this single-center cohort study, patients who visited our hospital dental clinic before cardiovascular surgery were prospectively recruited between April 2015 and July 2016. Patients were excluded if they were edentulous, of unstable general physical condition, required reoperation, or died during hospitalization. Information on primary illness, comorbidities, and treatments were retrieved from patient records. The study’s protocol was approved by the Institutional Review Board of Fujita Health University (Approval ID: 15-053). All participants signed an informed consent form prior to study enrollment. The study was performed in accordance with the Declaration of Helsinki.

Data collection

The bacteria counts in the following prespecified areas of the oral cavity were measured by a bacteria detection apparatus (Panasonic Healthcare, Tokyo, Japan) on the day before and 1, 4, and 7 days after surgery by experienced hygienists: 1) dorsal surface of the tongue (tongue), 2) buccal vestibule area of the lower right molars (buccal vestibule), and 3) buccal surface of the upper left last molar (tooth surface). If no molar teeth were present on the left side, bacteria were sampled on the right side for tooth surface measurements. The sampling methods were based on previous studies [11,20], so the procedures are only briefly described here. The number of oral bacteria changes throughout the day and can also change with oral care and oral intake. Samplings were performed before lunch time between 10 a.m. and noon to minimize the influence of measurement time. In cases of secretion pooling in the oral cavity due to tracheal intubation, oral bacteria were sampled after secretion removal by suctioning.

Data sampling of the three oral cavity areas was conducted in a standardized way based on previous studies [20,21]. Briefly, a sterilized swab connecting to a device exerting a constant 20 g force was pressed on the sampling area. A swab connected to a device exerting a constant 20 g pressure by being parallel to the device. The swab was swiped on the applicable area three times in a 10-mm width and then placed in distilled water in the bacteria detection apparatus for counting [21]. The dielectrophoretic impedance measurement technique was used for bacteria counting [21]. The estimated number of bacteria (CFU/mL) was recorded for analysis.
Table 1 Demographic data of participants

<table>
<thead>
<tr>
<th>Variable</th>
<th>Group</th>
<th>n       (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex</td>
<td>Male</td>
<td>24 (51.1)</td>
</tr>
<tr>
<td>Disease</td>
<td>Aortic stenosis</td>
<td>22 (32.9)</td>
</tr>
<tr>
<td></td>
<td>Aortic regurgitation</td>
<td>7 (46.8)</td>
</tr>
<tr>
<td></td>
<td>Mitral stenosis</td>
<td>1 (2.1)</td>
</tr>
<tr>
<td></td>
<td>Mitral regurgitation</td>
<td>17 (36.2)</td>
</tr>
<tr>
<td>Intubation at 1 day after surgery</td>
<td></td>
<td>23 (48.9)</td>
</tr>
<tr>
<td>Surgical procedure</td>
<td>Valve replacement</td>
<td>26 (55.3)</td>
</tr>
<tr>
<td></td>
<td>Valvuolaplasty</td>
<td>19 (40.4)</td>
</tr>
<tr>
<td>n</td>
<td>TA V*</td>
<td>2 (4.3)</td>
</tr>
</tbody>
</table>

*TA VI, transcatheter aortic valve implantation

Data analysis
The participants were divided into intubated and extubated groups according to the endotracheal intubation status 1 day after surgery. Logarithmic conversion of oral bacteria counts was performed before the statistical analysis. The differences in bacteria counts at each time point for the day before to 7 days after surgery were tested using repeated measure analysis of variance (ANOVA). Tukey’s test was adopted for multiple comparisons. The oral bacteria counts were compared between the intubated and extubated groups at each time point by means of Student’s t-test. Mauchly’s sphericity test for repeated ANOVA and Levene’s test for t-test was used to determine the effect size for repeated ANOVA and Levene’s test for t-test, respectively. Unaltered values were accepted if the P values were nonsignificant, confirming variance homogeneity.

Statistical analyses were performed using IBM SPSS Statistics 24.0 software (IBM, Armonk, NY, USA). The critical value for rejecting the null hypothesis was P < 0.05.

Results

Participant characteristics
A total of 47 patients (27 males and 20 females; mean age, 69.2 ± 9.52 years) were included in the study and their characteristics are summarized in Table 1. Overall, 23 patients were included in the intubated group (11 males and 12 females; mean age, 70.0 ± 9.63 years) and 24 patients in the extubated group (16 males and 8 females; mean age, 69.9 ± 11.5 years). No remarkable age difference existed between both groups.

Changes in the oral bacteria count during the perioperative period
The mean perioperative changes in bacteria count (log CFU/mL) on the tongue, buccal vestibule, and tooth surface are shown in Fig. 1. The bacteria count on the tooth surface significantly increased from the day before surgery to 1 day after surgery in both the intubated and extubated groups (P < 0.001), significantly decreased from that day to 4 days after surgery (P < 0.02). The bacteria count on the tooth surface remained unchanged from 4 days to 7 days after surgery. Bacteria count on the buccal vestibule showed the same tendency, being significantly increased 1 day after surgery (P < 0.001), significantly decreased 4 days after surgery (P < 0.01), and relatively unaltered 7 days from 4 days after surgery.

The bacteria count on the tongue surface did not change significantly during the perioperative period in the extubated group (P = 0.80). In the intubated group, the mean bacteria count on the tongue was significantly higher 1 day after surgery compared with 4 days after surgery (P < 0.01).

Comparison of oral bacteria counts between the intubated and extubated groups
No statistical differences were observed in the oral bacteria count at any oral cavity area on the day before surgery between the intubated and extubated patients. On the day after surgery, the mean bacteria count on the tooth surface was significantly higher in the intubated group (7.12 ± 0.64 log CFU/mL vs. 6.73 ± 0.94 log CFU/mL; P = 0.01). No remarkable differences were observed in bacteria count on the tongue surface between the two groups (P = 0.33).

Discussion
The present study showed that the oral bacteria count significantly increased immediately after heart surgery, especially in intubated patients, but returned to baseline values several days afterwards. Previous reports have shown that perioperative oral health care could decrease the risk of pneumonia and improve prognosis in gastrointestinal cancer and heart surgery cases [2,3,9], as oral bacteria are nosocomial pneumonia-suspected pathogens [1]. Findings from this study support the notion that increased oral bacteria numbers after surgery may be a risk factor for postoperative pneumonia.

Bacteria counts on the tooth surface and buccal vestibule were found to be significantly increased from the day before surgery until 1 day after surgery, regardless of the endotracheal intubation status. Heart valve surgery is highly invasive, and postoperative care is usually managed in the intensive care unit. During critical care, a low level of consciousness, no oral feeding, and a dull swallowing reflex may increase the pool of secreted saliva in the oral cavity [10]. Those factors may have been implicated in the increase in oral bacteria 1 day after surgery in the present cohort.
The bacteria numbers on the tooth surface and buccal vestibule returned to baseline values 4 days after surgery, when patient consciousness was presumably higher and oral feeding was restarted in the absence of severe postoperative complications. Kawano reported that oral bacteria increased 2 days after surgery in patients with gastrointestinal cancer [19], which was consistent with the present study. Findings of postoperative oral bacteria increase also support the results of previous reports regarding the effect of perioperative oral management on reduction of postoperative infections [22,23]. Our results highlight the importance of intensive oral care in the critical days following highly invasive heart valve surgery.

The increase in the oral bacteria numbers 1 day after surgery at the tooth surface and buccal vestibule was more significant in intubated patients. Patients are usually sedated during the intubation period. Again, a low consciousness level may induce a decrease in swallowing or coughing reflex, resulting in an increase in contaminated pooled saliva secretions in the oropharyngeal region [10]. Our previous study showed that the oral bacteria counts were significantly higher during intubation than after extuba- tion in intensive care unit patients [11]. Microorganisms present in the biofilm forming the endotracheal tube are associated with the onset of VAP [12]. Pooled oral secretions flow along the tube into the trachea, leading to lower respiratory infection during ventilation. Accordingly, such oral secretion pooling is another risk factor for VAP in patients with endotra- cheal intubation [24]. Systemic oral care during the intubated period can significantly reduce the oral bacteria count [11]. Based on our findings and the above, daily oral care during intubation period is advised to reduce bacteria in the perioperative period of invasive surgery. After extubation, changes in oral bacteria counts may be influenced by several factors such as oral intake, number of teeth, and compliance to tooth brushing. In this study, although the oral bacteria count more than 4 days after surgery did not differ between groups, these factors may have affected the bacteria counts.

The bacteria counts were only significantly increased 1 day after sur- gery on the tooth surface and buccal vestibule mucosa. In contrast, the bacteria count on the tongue surface was persistently high and did not remarkably vary throughout the perioperative period. Our results are consistent with those of previous reports [19,20]. Sachdeo et al. reported that bacteria counts were highest on the dorsal surface of the tongue and lowest on the labial vestibules and palate in edentulous older adults [25]. They also reported that the microbial species on the dorsal tongue surface were in the same cluster as in saliva. Although standardization tongue surface hygiene care using a toothbrush was introduced in this study, intensive tongue cleaning may be necessary to elicite significant changes in the bacte- ria count on the tongue surface. Further studies are warranted to elucidate the effects of intensive tongue surface cleaning on the decrease in bacteria numbers on the tongue.

This study had several limitations. First, it was an observational study and did not include a control group without oral health care intervention. With several recent reports on the benefits of perioperative oral health and its recent incorporation in heart valve surgery clinical path in hospi- tals, it is ethically and clinically difficult to establish a control group not receiving perioperative oral inspection and treatment. Oral management by dentists and dental hygienists consisting of pre-operative periodontal treatment and postoperative bedside oral health care has been routinely conducted for hospitalized patients undergoing surgery in Japan since its introduction in the national health care system in 2012. Accordingly, pre-operative periodontal treatment was performed to all participants in this study, which may have reduced the levels of oral bacteria on the tooth surface and mucosa before surgery. Secondly, our study reported changes in oral bacteria counts during the perioperative period, but did not assess its association with pneumonia incidence after surgery. As the incidence of postoperative pneumonia is currently low in patients undergoing heart valve surgery, a much larger sample size will be required to investigate the association between oral bacteria counts and pneumonia incidence after heart valve surgery.

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Conflict of interest
The authors have no conflict of interest to declare.

References