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研究題目：心臓弁膜症手術患者における口腔機能と術後全身状態の関連について

目　的：

Oral health status is closely related to general health condition. In the hospital setting, perioperative oral management（POM）has attracted much attention, as definite improving effects of patient systemic conditions have been reported. Previous studies have demonstrated reducing effects on postoperative pneumonia, surgical site infection, and mortality after surgery due as a consequence of POM in cancer surgery patients. Missing teeth can be a manifestation of oral or systemic diseases and a reflection of patients' condition. However, the association of tooth number with postoperative outcomes in cardiovascular surgery patients has not been fully investigated. Therefore, the aim of this study is to examine the association between the number of remaining teeth and the incidence of postoperative respiratory complications in heart valve surgery patients.

対象および方法：

1. Subjects

The present retrospective observational study was conducted at a single-center of Kagoshima University Hospital, Japan. The medical records of 157 adult patients who underwent heart valve surgery and received POM between April 1, 2010, and March 31, 2019, were examined in this study. The inclusion criteria were adults ≥ 20 years who underwent open heart surgery for valvular heart disease and received POM. No exclusion criteria were implemented. The study protocol was approved by the ethics committee of the Kagoshima University Graduate School of Medical and Dental Sciences（number：190057）.

2. Perioperative oral management

Before surgery, dentists examined patients' oral condition and assessed for dental caries, periodontal status, X-ray examination and oral hygiene status. If necessary, the dentist extracted teeth suspected to be a source of infection, and fixed mobile teeth to prevent them from falling out during intubation. The dental hygienists gave oral hygiene instructions, removed dental plaque using a tooth brush and adjunctive aids, including interdental brush and uni-tuft brush, and eliminated dental calculus using an ultrasonic scaler. After the surgery, the dentists examined oral condition and the dental hygienists performed oral care to maintain oral hygiene in the intensive care unit. Dental hygienists removed dental plaque and oral secretions using a tooth brush and adjunctive aids, including interdental brush and uni-tuft brush. During these

procedures, suction was used to avoid aspiration. After discharge from the hospital, oral health care was continued in our department or the patient's family dental clinic.

3. Outcomes

Outcomes were the incidence of postoperative respiratory complications, including pneumonia, atelectasis, emphysema, bronchitis, and pulmonary edema.

4. Variables

Systemic risk factors were extracted from medical records according to reported risk factors for valvular heart disease. Age, sex, body mass index（kg/m^2）, hypertension, diabetes mellitus, dialysis, operating time（minute）, controlling nutritional status score before surgery（>2）, preoperative meal type（other than regular meal）, union valvular disease, atrial fibrillation, concomitant coronary artery bypass grafting, past cardiac surgery experience, infective endocarditis, New York Heart Association functional classification（NYHA）class IV, and left ventricular ejection fraction（%）were extracted as covariates. Oral risk factors were extracted from medical records, dental examination and X-rays referring to a previous report, and a new item of oral hygiene status was included. The number of remaining teeth（including wisdom teeth）, denture use, tooth extraction before surgery, Eichner classification, periodontitis, and O'Leary's plaque control record（%）were extracted as covariates.

5. Data analysis

The subjects were divided into two groups based on the number of remaining teeth（≥ 20, < 20）according to previously described reports. Patient demographic and clinical characteristics were compared between groups, and mean values, standard deviations, medians, 25-75 percentiles, and P-values were calculated. We used the x^2-test or Fisher's exact test for categorical values, and used Student's t test or the Mann-Whitney U test for continuous values. Next, we performed logistic regression analysis including all systemic and oral background factors except the number of remaining teeth, and calculated the propensity score. The propensity score was used as a representative covariate of all background factors except the number of remaining teeth. Logistic regression analysis was conducted to examine the association between the number of remaining teeth and the incidence of postoperative respiratory complications. Finally, subgroup analyses were performed by stratifying data into quintiles based on the propensity score. Odds ratios and 95% confidence intervals were calculated. The level of significance was set at $P \leq 0.05$. Receiver operating characteristic analysis was performed to evaluate the validity of the propensity score. We employed EZR（Saitama Medical Center, Jichi Medical University, Saitama, Japan）, which is a graphical user interface for R（The R Foundation for Statistical Computing, Vienna, Austria）, for statistical analysis.

結果および考察：

1. Patient demographics and clinical characteristics

Twenty-two edentulous subjects were included, and the mean number of remaining teeth in all patients was 15.2 ± 9.8. The patients were divided into two groups according to the number of teeth（≥ 20, n＝62；＜ 20, n＝95）. Patients with ＜ 20 remaining teeth were older（P ＜ 0.001）and had a higher body mass index（P＝0.001）than those with ≥ 20 remaining teeth. The ratio of patients with hypertension and NYHA class IV was significantly higher（P ＝0.002 and 0.009）in those with ＜ 20 remaining teeth than in those with ≥ 20 remaining teeth；the opposite was observed for the ratio of those with past cardiac surgery（P ＝ 0.027）. The prevalence of denture use, tooth extraction before surgery, and periodontitis was significantly higher（P ＜ 0.001, 0.020, and 0.001）in patients with fewer teeth. Occlusal support, which was evaluated with the Eichner classification, was better（P ＜ 0.001）in patients with more teeth.

2. Incidence of postoperative respiratory complications

Incidence of each respiratory complication is shown in Table 1. Pneumonia occurred most often in patients with ＜ 20 remaining teeth. Next, we calculated the propensity score to adjust background factors（Table 2）. According to receiver operating characteristic analysis, the area under the curve for the propensity score was 0.965（95% confidence interval, 0.939-0.992）. Before adjustment by propensity scoring, no significant association was observed between the number of remaining teeth and the incidence of postoperative respiratory complications（Table 3）. Logistic regression analysis after adjustment by propensity scoring, however, showed that patients with ＜ 20 remaining teeth had a significantly higher incidence of postoperative respiratory complications than those with ≥ 20 remaining teeth, with an odds ratio of 29.800（95% confidence interval, 3.010-295.000；P＝0.004）（Table 3）. However, a statistically significant difference in calculated propensity scores was observed between the two groups（Table 2）. Therefore, we performed subgroup analysis by stratifying the data into quintiles based on the propensity score. As a result, the odds ratio for the patients with ＜ 20 remaining teeth was 9.000（95% confidence interval, 1.140-71.300；P＝0.038）（Table 3）.

Table 1　Incidence of postoperative respiratory complications

Complication	Number of patients	
	Number of teeth（≥ 20）	Number of teeth（＜ 20）
Pneumonia	2	10
Atelectasis	1	1
Emphysema	0	2
Bronchitis	0	3
Pulmonary edema	1	0
Total	4	16

Table 2　Calculated propensity scores for two groups

Number of teeth	Propensity score†	P value
≥ 20	0.150 ± 0.246	< 0.001
< 20	0.850 ± 0.222	

† Values are mean ± standard deviation.

Table 3　Incidence of postoperative respiratory complications in patients with < 20 remaining teeth

Method	Odds ratio（95% confidence interval）†	P value
Before adjustment by propensity scoring	2.940（0.933–9.250）	0.065
After adjustment by propensity scoring	29.800（3.010–295.000）	0.004
Subgroup analysis	9.000（1.140–71.300）	0.038

† With reference to patients with ≥ 20 teeth.

In the present study, we found that a lower number of teeth is associated with the incidence of postoperative respiratory complications in patients undergoing heart valve surgery. Ogawa et al.（2021）showed that the incidence of postoperative pneumonia was significantly higher in patients with＜10 remaining teeth than in those with ≥ 20 teeth by Fisher's extract test. However, they did not find a significant association between postoperative pneumonia and the number of remaining teeth after adjusting for confounding variables in multivariable logistic regression analysis. In the present study, we adjusted for confounding variables using the propensity score and demonstrated a significant association between postoperative respiratory complications and the number of remaining teeth. After adjustment of confounding variables, an odds ratio of 29.800 was obtained. However, calculated propensity scores for patients with < 20 remaining teeth and those with ≥ 20 remaining teeth were statistically different, meaning that the background factors were not fully adjusted. To remedy this shortcoming, we subsequently performed subgroup analysis by stratifying data into quintiles based on the propensity score. Finally, an odds ratio of 9.000, which indicates a large effect size, was obtained. The differences in the association of remaining teeth number with postoperative complications observed in these two studies seem to be due to the difference in the method of analysis used. We used the propensity score to adjust background factors, increasing the evidence level compared with the previous study.

成果発表：（予定を含めて口頭発表、学術雑誌など）

Terano K, Motoi T, Nagata E, Oho T. Association of remaining tooth number with postoperative respiratory complications in heart valve surgery patients. Int J Dent Hygiene, in press, doi：10.1111/idh.12673.