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Perioperative Changes in Oral Function and Association With Oral Food Intake Status in Patients Undergoing Gastric and Oesophageal Cancer Surgery

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ABSTRACT

Objectives: Perioperative oral health care traditionally focuses on oral hygiene to prevent post-surgical infection, with limited attention to oral function. This study explores perioperative changes in oral function in association with oral food intake in patients receiving gastric or oesophageal cancer surgery.

Methods: Patients who underwent surgery for gastric or oesophageal cancer at a university hospital and visited its outpatient dental centre for perioperative oral health care were recruited from August 2018 to March 2021. Several oral function parameters (lip-tongue motor function, tongue pressure, occlusal force, oral dryness and dysphagia score) were measured 1 day before and 7 days after treatment. The patients were categorised into the oral intake (PO) and non-oral intake (NPO) groups based on oral food intake status at 7 days post-surgery, and perioperative changes in oral function were analysed using the Wilcoxon signed-rank test between the PO and NPO groups for both gastric and oesophageal cancers.

Results: Of the 298 gastric cancer patients and 71 oesophageal cancer patients analysed, 87% and 24% of patients, respectively, were capable of oral food intake at 7 days after surgery. In gastric cancer patients, oral hygiene, tongue pressure and dysphagia scores significantly worsened in the PO group. In contrast, oral hygiene, tongue pressure and dysphagia scores were all significantly worsened in the oesophageal cancer NPO group, but not in the PO group. Oral dryness and occlusal force did not change remarkably regardless of oral food intake status in these patients.

Conclusions: This study uncovered a significant decrease in oral function in oesophageal cancer patients without postoperative oral food intake, suggesting a potential association between impaired oral motor function and delayed oral intake recovery. Accordingly, perioperative oral function management alongside oral hygiene care is advisable for early resumption of oral food intake.

1 | Background

Preventing such complications as surgical site infection and postoperative pneumonia is critical in cancer patients for prompt recovery and avoiding prolonged hospitalisation, delayed resumption of oral intake and potential disuse syndrome. The incidence of postoperative pneumonia reportedly ranges from 1.6% to 12.8% in gastric cancer patients [1] and 22.5% to

38.8% in oesophageal cancer patients [2, 3]. Since perioperative oral health care reduces the risk of ensuing complications and shortens hospitalisation time [4, 5], it is routinely implemented under the national health insurance system in Japan.

Preoperative sarcopenia is another reported factor that influences postoperative outcomes [6]. Characterised by reduced skeletal muscle mass and strength, this condition may slow functional recovery to preoperative activity levels. As systemic muscle weakness has been associated with an elevated risk of postoperative complications [7], perioperative nutritional management is recommended. However, sarcopenia is also related to declined oral function [8] and subsequently poor nutritional status [9] to create a vicious cycle. A prolonged postoperative non-oral feeding status can lead to oral muscle disuse [10], thus exacerbating systemic muscle weakness and nutritional decline [11].

The concept of "oral hypofunction" was first proposed by the Japanese Society of Gerodontology to describe oral function deterioration and draw attention to oral function decline in older adults [12]. Oral hypofunction (OHF) comprises seven subsymptoms and is diagnosed when at least three symptoms meet the cut-off criteria. The quantitative assessment of specific oral function decline is crucial for monitoring oral condition and preserving oral health and nutritional intake ability. However, few reports have addressed the quantitative changes in oral function during the perioperative period and their association with nutritional status.

Our previous study demonstrated that non-oral feeding status significantly influenced the perioperative decline in tongue pressure among patients undergoing upper gastrointestinal (GI) cancer surgery; but not in patients with lung or genitourinary cancers [7]. Although that study highlighted a decline in tongue pressure among upper GI cancer patients, it had limitations that the patient cohort included both oesophageal and gastric cancer cases, and tongue pressure was assessed only up to 4 days postoperatively in a relatively short observation period. Given that the invasiveness of surgery and the incidence of postoperative complications differ between gastric and oesophageal cancer procedures, the generalisability of the findings was limited. Therefore, the present study aimed to investigate perioperative changes in oral function in association with oral intake status separately in patients undergoing surgery for gastric or oesophageal cancer, extending the postoperative observation period to 7 days to minimise the immediate effects of surgical invasion.

2 | Materials and Methods

2.1 | Participants

This study's protocol was approved by the Institutional Review Board of Tokyo Medical and Dental University and Fujita Health University (approval ID: HM20-200 and D2021-100). We recruited patients with gastric or oesophageal cancer who visited a hospital dental clinic before surgery between August 2018 and March 2021 at a university hospital. The inclusion criteria for this study were (1) 20 years or older and (2) having the ability to visit an outpatient dental clinic. The exclusion criteria were (1) impaired consciousness, (2) refusal to receive dental care, (3) unstable general condition, (4) prolonged admission to the intensive care unit and (5) the presence of acute symptoms or severe pain in the oral cavity. All participants provided verbal informed consent prior to enrolment in this study.

2.2 | Assessment of Oral Function

The patients were assessed for oral function on the day before and 7 days after surgery. Dentists and dental hygienists trained in standardised evaluations conducted all examinations. The measured items were based on the definition of OHF proposed by the Japanese Society of Gerodontology in 2016 as the integrated deterioration of multiple oral functions [12]. The measurement details and OHF cut-off thresholds are described in a previous report [12] and described here briefly (Table 1). OHF was diagnosed as meeting at least three of the seven oral subsymptom criteria.

1. Oral hygiene (Hygiene): The degree of tongue coating was assessed using the Tongue Coating Index (TCI) via visual inspection. The tongue surface was divided into nine sections and each section was scored on a three-point scale (0: none, 1: moderate, 2: severe). The total score was calculated to determine the TCI [13]. A TCI score of 9 or higher (i.e., ≥ 50%) was classified as poor oral hygiene.

TABLE 1 | The seven oral sub-symptoms of oral hypofunction and their cut-off criteria.

Oral sub-symptom	Cut-off criterion
Oral hygiene (Hygiene)	Total number of bacteria $> 10^{6.5}$ CFU/mL
Oral dryness (Dryness)	Measured value with a moisture checker < 27.0
Maximum occlusal force (MOF)	Occlusal force < 200 N
Lip-tongue motor function (LTMF)	Utterance count of/pa/, /ta/ or/ka/ < 6/s
Maximum tongue pressure (MTP)	Maximum tongue pressure < 30 kPa
Masticatory function (Mast-F)	Glucose concentration in chewing test < 100 mg/dL
Swallowing function (Swal-F)	Total Eating Assessment Tool (EAT-10) score ≥ 3

2. Oral dryness (Dryness): Oral dryness was measured using an oral moisture checker (Mucus; Life Co. Ltd., Saitama, Japan) [14, 15]. The device sensor was placed on the participant's right-side buccal mucosal surface for 2 s. Measurements were performed in triplicate at the same site and the mean value was calculated.
3. Maximum occlusal force (MOF): MOF was determined during a 3-s clenching task using pressure-indicating film (Dental Prescale II; GC Corp., Tokyo, Japan) [16]. The area of colour change on the sheet caused by clenching was analysed with dedicated software to calculate occlusal force, which was then log-transformed for statistical analysis.
4. Lip-tongue motor function (LTMF): Participants were instructed to repeat the syllables/pa/, /ta/ or/ka/ as many times as possible within 5 s. The number of repetitions was recorded using a digital counter (Kenkokun Handy; Takei Scientific Instruments Co. Ltd., Japan) [17]. The minimum utterance rate (/s) among/pa/, /ta/ and /ka/ was calculated for analysis.
5. Maximum tongue pressure (MTP): MTP was measured using a balloon probe connected to a digital tongue pressure meter (TPM-01; JMS Co. Ltd., Hiroshima, Japan). The probe was placed on the dorsal surface of the tongue, and participants were instructed to press the probe against the hard palate with maximum strength for 3 s [18]. After several practice trials, measurements were taken three times, and the mean value was calculated.
6. Masticatory function (Mast-F): Masticatory function was evaluated using a 2-g gummy jelly. Participants were instructed to chew the jelly without swallowing the bolus or saliva for 20 s. After chewing, they held 10 mL of distilled water in their mouth and expelled the mixture into a cup with a funnelled mesh. The amount of eluted glucose was measured using a masticatory ability testing system (Gluco Sensor GS-II; GC Corp., Tokyo, Japan) [19].
7. Swallowing function (Swal-F): Swallowing function was assessed using the self-administered 10-item Eating Assessment Tool (EAT-10). Results were expressed as a numerical score ranging from 0 to 40 [20].

2.3 | Physical Condition

Patient details regarding preoperative cancer stage classification, history of hypertension, diabetes mellitus, chronic obstructive pulmonary disease (COPD) and the presence or absence of preoperative chemotherapy were extracted from medical records. Height and weight were also recorded for calculations of body mass index (BMI).

2.4 | Functional Oral Intake Scale (FOIS)

Diet level before surgery was determined by their attending physicians. Nutritional counselling was conducted before surgery based on the patient's general and nutritional status. Postoperative diet level was determined by bedside swallowing evaluations by speech therapists (STs) or instrumental swallowing evaluations by the multidisciplinary dysphagia support team if post-operative dysphagia was suspected. Then, information on nutrition route and oral food intake level was extracted from medical charts. Oral food intake status at each time point was assessed using the FOIS [21], a tool that categorises oral intake status from 1 (lowest) to 7. Based on FOIS level at the postoperative oral assessment, the subjects were divided into two groups: FOIS 1–3 patients were defined as having a non-oral diet (NPO group) and received nutrition primarily from tube feeding, whereas FOIS 4–7 patients were considered to follow a totally oral diet (PO group) ranging from a single consistency to a regular diet.

2.5 | Data Analysis

The perioperative changes in each OHF category were analysed separately for the PO and NPO groups for both gastric and oesophageal cancer patients.

Age and BMI were analysed using *t*-tests, with sex distribution, hypertension, diabetes mellitus, COPD and the proportion of patients receiving preoperative chemotherapy assessed using the chi-squared test.

Since the normal distribution of the data was not found in several categories based on the Shapiro–Wilk test, perioperative changes in oral function values were evaluated using the Wilcoxon signed-rank test. If a sub-symptom could not be measured due to physical or cognitive restrictions, it was classified as meeting the respective OHF criterion. We then calculated the proportions of participants who met the criterion for each OHF sub-symptom and overall OHF. Perioperative changes in the frequency of OHF were evaluated using McNemar's test.

The critical value for rejecting the null hypothesis was $p < 0.05$. All statistical analyses were performed using SPSS Statistics 28.0 software (IBM, Armonk, NY, USA). This study followed the STROBE statement.

3 | Results

3.1 | Participant Characteristics at Baseline

Figure 1 presents the flow-chart of participant selection and analysis. After recruiting 331 consenting patients with gastric cancer and excluding 33 patients, we ultimately included 298 patients for analysis (Table 2). Among the patients with oesophageal cancer, 71 of 76 were included in the study (Table 2). At the postoperative oral assessment, 40 gastric cancer patients (17.5%) and 54 oesophageal cancer patients (76.1%) were incapable of oral feeding and categorised into the NPO group. Regarding medical history, we observed no significant differences between the PO and NPO groups apart from a higher frequency of hypertension in gastric cancer patients ($p = 0.015$). Cancer staging for the gastric and oesophageal cancer patients is summarised in Table 3.

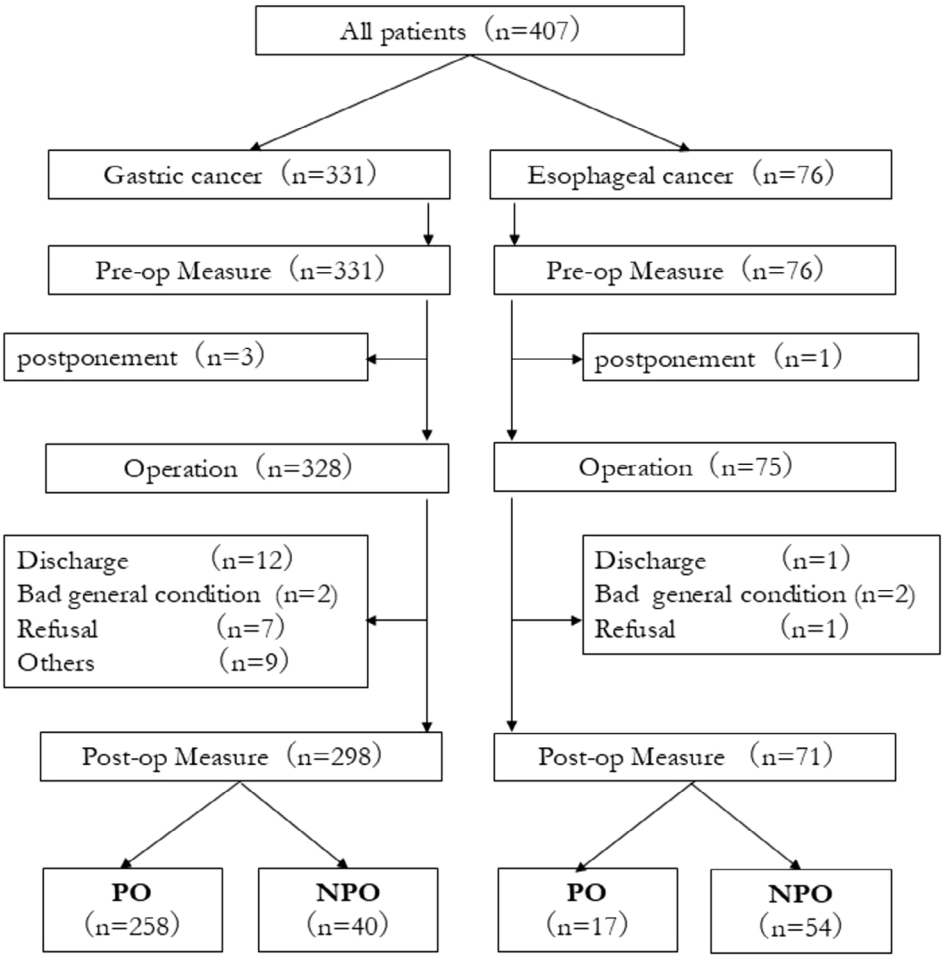

FIGURE 1 | Schematic flow chart of study participants.

TABLE 2 | Baseline patient characteristics.

	Gastric cancer			Oesophageal cancer		
	PO (*N*=258)	**NPO (*N*=40)**	***p***	**PO (*N*=17)**	**NPO (*N*=54)**	***p***
Age, years (mean, SD)	69.3 (10.5)	69.8 (12.2)	0.818	66.4 (9.3)	64.7 (10.2)	0.559
BMI (mean, SD)	22.8 (3.2)	23.4 (3.2)	0.295	21.8 (4.1)	22.9 (2.8)	0.311
Female (*N*, %)	80 (31.0)	7 (17.5)	0.080	1 (5.9)	11 (20.4)	0.165
Hypertension (*N*, %)	102 (39.5)	24 (60.0)	**0.015**	5 (29.4)	23 (42.6)	0.332
Diabetes mellitus (*N*, %)	43 (16.7)	10 (25.0)	0.200	3 (17.6)	6 (11.1)	0.480
COPD (*N*, %)	4 (1.6)	0 (0.0)	1.000	1 (5.9)	1 (1.9)	0.424
Preoperative chemotherapy (*N*, %)	13 (5.0)	3 (7.5)	0.459	3 (17.6)	18 (34.0)	0.240

Note: Signicant differences ($p<0.05$) are highlighted in bold.

3.2 | Perioperative Changes in Oral Function in the PO and NPO Groups

In gastric cancer patients, significant declines were observed postoperatively for Hygiene ($p<0.001$), MTP ($p=0.006$) and Swal-F ($p=0.046$) in the PO group, with no significant perioperative changes in oral function in the NPO group (Table 4). Among oesophageal cancer patients, while the PO group showed no remarkable perioperative declines in any oral function measure, the NPO group exhibited significant decreases in Hygiene ($p<0.001$), tongue pressure ($p<0.001$) and Swal-F ($p<0.001$) (Table 4).

3.3 | Perioperative Changes in OHF Prevalence Rate

Among gastric cancer patients, neither the PO nor the NPO group displayed significant perioperative changes in the

TABLE 3 | Tumour grading.

	Gastric cancer		Oesophageal cancer	
	PO (*N* = 258)	**NPO (*N* = 40)**	**PO (*N* = 17)**	**NPO (*N* = 54)**
I	105 (40.7)	15 (37.5)	3 (17.6)	15 (27.8)
II	69 (26.7)	16 (40.0)	4 (23.5)	19 (35.2)
III	53 (20.5)	6 (15.0)	7 (41.2)	11 (20.4)
IV	17 (6.6)	2 (5.0)	1 (5.9)	3 (5.6)
GIST	5 (1.9)	0 (0.0)		
Unknown	9 (3.5)	1 (2.5)	2 (11.8)	6 (11.1)

Note: Data are expressed as *N* (%).

TABLE 4 | Perioperative changes in oral function for gastric and oesophageal cancer patients in the PO and NPO groups.

	PO				NPO			
	N	**Pre-op**	**Post-op**	***p***	***N***	**Pre-op**	**Post-op**	***p***
Gastric cancer								
Hygiene (%)	256	16.7 (8.3–38.9)	27.8 (11.1–50.0)	**< 0.001**	40	33.3 (11.1–50.0)	36.1 (16.7–50.0)	0.145
Dryness	258	28.3 (27.2–29.4)	28.0 (26.6–29.2)	0.112	40	28.0 (26.2–29.5)	28.2 (27.2–29.0)	0.375
MTP(kPa)	256	32.4 (26.0–36.9)	31.6 (25.5–36.0)	**0.006**	40	30.5 (24.6–37.4)	28.5 (24.5–37.0)	0.350
MOF (N. $\log_{10}$)	253	2.8 (2.5–3.0)	2.8 (2.5–3.0)	0.933	37	2.7 (2.4–3.0)	2.7 (2.4–3.0)	0.361
LTMF (number/s)	257	6.0 (5.5–6.5)	6.1 (5.5–6.5)	0.067	40	5.8 (5.1–6.3)	5.7 (5.2–6.1)	0.722
Mast-F (mg/dL)	244	166.0 (116.0–208.5)	164.0 (117.0–216.0)	0.215	23	162.0 (125.8–188.8)	172.0 (122.5–206.5)	0.726
Swal-F	257	0.0 (0.0–0.0)	0.0 (0.0–0.0)	**0.049**	38	0.0 (0.0–1.0)	0.0 (0.0–0.0)	0.602
Oesophageal cancer								
Hygiene (%)	17	33.3 (11.1–50.0)	22.2 (11.1–47.2)	0.256	54	16.7 (0–41.7)	38.9 (16.7–50.0)	**< 0.001**
Dryness	17	26.7 (26.7–29.2)	26.4 (26.4–29.6)	0.586	54	28.4 (27.5–29.6)	28.2 (26.6–29.6)	0.780
MTP(kPa)	17	29.4 (26.9–35.4)	29.8 (22.7–37.2)	0.227	54	33.3 (27.8–38.9)	32.6 (25.4–36.4)	**< 0.001**
MOF (N. $\log_{10}$)	16	2.7 (2.7–3.0)	2.8 (2.6–3.1)	0.679	52	2.8 (2.6–3.0)	2.9 (2.5–3.0)	0.482
LTMF (number/s)	17	6.1 (5.2–6.3)	5.8 (4.5–6.4)	0.124	51	6.1 (5.7–6.6)	5.9 (5.5–6.5)	0.066
Mast-F(mg/dL)	11	143.0 (86.5–213.3)	174.0 (109.5–214.0)	0.859	24	161.5 (114.8–224.3)	169.0 (127.0–225.5)	0.265
Swal-F	17	0.0 (0.0–8.5)	0.0 (0.0–6.0)	0.529	50	0.0 (0.0–1.3)	1.5 (0.0–17.3)	**< 0.001**

Note: Data are expressed as median (interquartile range). Signicant differences ($p < 0.05$) are highlighted in bold.
Abbreviations: LTMF, lip-tongue motor function; Mast-F, masticatory function; MOF, maximum occlusal force; MTP, maximum tongue pressure; Swal-F, swallowing function.

prevalence of overall OHF or meeting sub-category items apart from Hygiene in the PO group ($p = 0.003$) (Table 5). In oesophageal cancer patients, the prevalence of overall OHF increased significantly from 38.9% preoperatively to 72.2% postoperatively in the NPO group ($p < 0.001$), with no such changes in the PO group ($p = 0.375$). Regarding OHF sub-categories, the

TABLE 5 | Proportions of patients meeting the criteria for overall OHF and each OHF sub-symptom.

	PO			NPO		
	Pre-op	**Post-op**	***p***	**Pre-op**	**Post-op**	***p***
Gastric cancer (PO 258, NPO 40)						
Hygiene	54 (20.9)	79 (30.6)	**0.003**	14 (35.0)	17 (42.5)	0.508
Dryness	58 (22.5)	73 (28.3)	0.105	15 (37.5)	9 (22.5)	0.180
MTP	102 (39.5)	114 (44.2)	0.058	17 (42.5)	22 (55.0)	0.180
MOF	109 (42.2)	112 (43.4)	0.775	23 (57.5)	23 (57.5)	1.000
LTMF	157 (60.9)	148 (57.4)	0.314	26 (65.0)	27 (67.5)	1.000
Mast-F	54 (20.9)	50 (19.4)	0.627	13 (32.5)	20 (50.0)	0.065
Swal-F	20 (7.8)	31 (12.0)	0.080	4 (10.0)	7 (17.5)	0.375
OHF	95 (36.8)	104 (40.3)	0.336	22 (55.0)	25 (62.5)	0.453
Oesophageal cancer (PO 17, NPO 54)						
Hygiene	5 (29.4)	4 (23.5)	1.000	13 (24.1)	22 (40.7)	0.064
Dryness	5 (29.4)	6 (35.3)	1.000	10 (18.5)	15 (27.8)	0.332
MTP	9 (52.9)	9 (52.9)	1.000	16 (29.6)	19 (35.2)	0.453
MOF	7 (41.2)	7 (41.2)	1.000	21 (38.9)	22 (40.7)	1.000
LTMF	11 (64.7)	11 (64.7)	1.000	28 (51.9)	38 (70.4)	**0.021**
Mast-F	7 (41.2)	7 (41.2)	1.000	12 (22.2)	33 (61.1)	**< 0.001**
Swal-F	5 (29.4)	7 (41.2)	0.727	12 (22.2)	28 (51.9)	**< 0.001**
OHF	9 (52.9)	12 (70.6)	0.375	21 (38.9)	39 (72.2)	**< 0.001**

Note: Data are expressed as the *N* (%). Significant differences ($p < 0.05$) are highlighted in bold.
Abbreviations: LTMF, lip-tongue motor function; Mast-F, masticatory function; MOF, maximum occlusal force; MTP, maximum tongue pressure; OHF, oral hypofunction; Swal-F, swallowing function.

NPO group showed significant postoperative increases in the frequencies of LTMF ($p = 0.021$), Mast-F ($p < 0.001$) and Swal-F ($p < 0.001$) (Table 5).

4 | Discussion

This study investigated the perioperative changes in oral function and their association with oral intake status in patients receiving gastric or oesophageal cancer surgery. Postoperatively, oral function significantly declined in oesophageal cancer patients with NPO status, while perioperative changes in oral function were minimal in gastric cancer patients. These findings indicate that patients with prolonged non-oral feeding after highly invasive oesophageal cancer surgery may harbour an increased risk of oral function deterioration. Preoperative sarcopenia has been reported to increase the risk of ensuing complications [22, 23]. In addition to systemic muscle weakness, decline in oral motor function such as MTP or LTMF can delay the resumption of oral intake and contribute to aspiration pneumonia, malnutrition and other complications [24, 25]. Our results underscore the necessity of incorporating oral function management alongside oral hygiene care during the perioperative period, particularly in oesophageal cancer patients at high risk of postoperative events.

Patients with oesophageal cancer are prone to postoperative dysphagia due to surgical invasiveness and such complications as recurrent laryngeal nerve palsy [26]. In our study, 49.3% of postoperative oesophageal cancer patients (41.2% in the PO group and 51.9% in the NPO group) self-reported dysphagia, with an EAT-10 score of ≥ 3. Especially in the NPO group, the Swal-*F* score was significantly higher, indicating more severe dysphagia. Patients who remain in NPO status by postoperative day 7 are subject to an increased risk of oral function deterioration, which may further delay the resumption of oral feeding. As proper nutritional intake and oral care are critical, special attention should be given to oral function and health during extended periods of NPO status.

We observed that the oesophageal cancer NPO group showed significant postoperative declines in oral function and an increase in the prevalence of OHF. Since insufficient tongue movement and restricted jaw motion may impair eating efficiency and swallowing [7, 27, 28], appropriate stimulation of oral muscles through food intake is essential for maintaining function. In the absence of proper stimulation, oral function may deteriorate to result in impaired mastication and swallowing abilities [25, 29, 30]. Limited tongue and jaw movement in an NPO status contributes to reduced muscle strength. Our study corroborates an earlier report describing greater reductions in MTP over the

perioperative period in oesophageal cancer patients compared with gastric cancer patients [31]. Indeed, prolonged NPO status following highly invasive oesophageal cancer surgery may significantly diminish oral motor function and strength.

Oral hygiene status was also significantly worse in the oesophageal cancer NPO group. Extended NPO status and physical inactivity may reduce the self-cleaning action of the tongue, thereby worsening oral hygiene [27, 32]. The resulting poor oral hygiene and dysphagia in these patients increases the risk of postoperative pneumonia [4, 5]. Our findings suggest that both continuous oral hygiene care and oral rehabilitation are essential to reduce postoperative complication risk in patients with oesophageal cancer.

Preoperative sarcopenia significantly impacts post-surgical outcomes in cancer patients by increasing the risk of complications and worsening long-term prognosis [33]. In particular, oesophageal cancer patients frequently exhibit sarcopenia due to ageing and malnutrition, which compromises both short- and long-term outcomes. Preoperative nutritional management is therefore crucial [34], and the potential impact of oral function decline on nutritional status must be considered [35]. Comprehensive interventions, including nutritional support and oral function management, are recommended even before surgery [36].

Lastly, we witnessed no significant declines in oral function in the gastric cancer NPO group. However, the prevalence of overall OHF in these patients remained high, with 55.0% affected preoperatively and 62.5% post-operatively. Although the perioperative scores for MTP and LTMF did not show significant declines regardless of oral intake status, Taniguchi et al. [7] reported significant MTP reductions on post-operative Day 4 in upper GI cancer patients, particularly among those with no oral nutritional intake. Thus, OHF and nutritional status may still have clinical associations in patients receiving cancer surgery [37]. Our results support that preoperative evaluation of oral function and nutritional status has benefit in gastric cancer patients as well.

5 | Limitations

One limitation of this study was that some OHF components could not be assessed in certain patients, particularly those who underwent highly invasive surgeries, with measurement not feasible on post-operative Day 7. This issue was especially prominent in the NPO groups, in which many patients could not undergo Mast-F assessment with a gummy jelly in their compromised state. Patients unable to complete the measurements were likely to have lower actual scores, suggesting that the reported average values might underestimate the actual extent of functional decline. Although this study focused on descriptive comparisons, we acknowledge that clinical cancer stage may have influenced post-operative oral intake and oral function outcomes. Future studies with larger sample sizes are warranted to explore these associations, while adjusting for cancer stage and other relevant confounders.

6 | Conclusions

This study evaluated perioperative changes in oral function associated with oral intake status in patients undergoing gastric or oesophageal cancer surgery. Even on post-operative Day 7, oesophageal cancer patients with NPO status displayed significant declines across several oral functions and a notably higher prevalence of OHF. Our results suggest that for such patients at high risk of complications, perioperative management should include not only routine oral hygiene care to prevent pneumonia, but also oral function management to facilitate the early recovery of eating function.

Author Contributions

Misaki Tanaka, Koichiro Matsuo: study design and conceptualisation. Misaki Tanaka, Koichiro Matsuo: statistical analysis. Misaki Tanaka, Koichiro Matsuo: interpretation of data. Misaki Tanaka, Koichiro Matsuo: drafting and revision of manuscript. Review of manuscript: all authors reviewed and approved the final version of the manuscript.

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Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

Data on the results of this study are available from the corresponding author upon request.

Peer Review

The peer review history for this article is available at https://www.webofscience.com/api/gateway/wos/peer-review/10.1111/joor.70014.

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