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ORIGINAL ARTICLE

A Systematic Review of Swallowing Training Measures for Postoperative Oral Cancer Patients

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Abstract
Swallowing disorder is one of the most common postoperative complications for oral cancer patients and seriously influences quality of life. Limited attention has been paid to evaluating swallowing training measures in postoperative oral cancer patients. This study systematically reviewed swallowing training measures for these patients. A comprehensive search strategy was undertaken across various databases for studies published between database inception and 15 June 2021. Raters independently judged titles, abstracts and full articles for selection according to inclusion and exclusion criteria. The included literature was evaluated for quality and data were extracted. Meta-analyses were conducted using RevMan 5.3. Ten intervention studies (four randomized controlled trials and six quasi-experimental studies) involving 588 patients were identified. Across the studies, most started in the early postoperative stage; however, there were differences in starting time, training time and duration, and type of training. We summarized four training methods: oral exercise, oral sensory stimulation, compensatory strategies and protective airway manoeuvres. The meta-analysis indicated that swallowing training could improve patients' swallowing function and quality of life in the short term, but the long-term effects were not obvious. Swallowing training mostly occurred in the early postoperative period and training measures were often used in combination. The timing, frequency and content of interventions varied between studies, and the effectiveness of any single measure was unclear. High-quality randomized controlled trials are necessary to study the efficacy and clinical applicability of various training measures, to provide a theoretical basis for their optimal selection and to develop a standardized training programme for postoperative oral cancer patients.

Keywords Oral cancer · Dysphagia · Swallowing training · Systematic review

Introduction

Oral cancer is one of the top 10 most common malignancies in the world. According to the GLOBOCAN 2018 estimates, the annual number of new cases diagnosed was 354 863, with 177 384 annual mortalities from oral cancer [1]. Oral cancer seriously influences health and quality of life and causes a massive economic and social burden.

Oral cancer is primarily treated with surgery, supplemented by radiotherapy and chemotherapy [2, 3]. Because of the specificity of the tumour site, the surgery involves several important structures including the mouth, pharynx and neck, which inevitably severely disrupts the normal physiological anatomy of the oral cavity, causing damage to organs, muscles and nerve tissues and leading to a certain degree of oral dysfunction [4]. Dysphagia is one of the most common complications of postoperative oral cancer, with an incidence ranging from 66 to 88% [5, 6], and even up to 98% 7 days after surgery [7]. Dysphagia can lead to postoperative complications such as aspiration, pulmonary infections, malnutrition, anxiety and depression, which can have a severe impact on patients' quality of life [8].

Swallowing training may improve the swallowing function of patients [9, 10]. However, studies of swallowing training have mainly focused on patients with neurogenic dysphagia represented by stroke, Parkinson's disease and other central nervous system diseases [11–14]. Neurogenic dysphagia is mainly caused by damage to the central nervous

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system and peripheral nerve, leading to the inability to maintain normal swallowing movements [15]. The focus of swallowing training is to stimulate sensorimotor neural regulation mechanisms in the cerebral cortex.

Although some researchers have explored the efficacy of swallowing training for patients undergoing radiotherapy and/or chemotherapy for head and neck cancer, dysphagia in these cases is mainly attributed to tissue fibrosis caused by radiation, resulting in damage to the lymphatic circulation, tissue oedema, and decreased stiffness and elasticity of swallowing-related muscles [16, 17]. In addition, the subjects have mainly been patients with laryngeal or esophageal cancer. Dysphagia in patients after oral cancer is mainly caused by damage to the normal operation of the swallowing structure, with denervation of the repaired tissue flap meaning it cannot move autonomously [18]. Swallowing training in these patients is conducted to promote the recovery of motor and sensory function of the injured parts, such as the muscles and nerves, and to promote the functional compensation of residual tissues, to ensure safe and efficient swallowing [19]. At present, less attention has been paid to patients after oral cancer surgery, and the associated swallowing training methods, timing and effectiveness in these patients, are different.

Therefore, the aim of this study was to summarize the swallowing training methods used and intervention characteristics in postoperative oral cancer patients, and to evaluate the effects of interventions on swallowing function and quality of life, to provide a foundation for clinical professionals.

Materials and Methods

Inclusion and Exclusion Criteria

Inclusion Criteria

The following inclusion criteria were used: (1) study population: primary oral cancer, aged ≥ 18 years; (2) interventions: any training to improve swallowing function after surgery, including oral exercises, oral sensory stimulation, airway protection manoeuvres, posture adjustment and dietary texture adjustment; (3) primary outcome indicators: evaluation of the safety and/or efficacy of swallow, including objective or subjective indicators such as the water swallowing test (WST), Eating Assessment Tool-10 (EAT-10), videofluoroscopic swallowing study (VFSS), and aspiration or adverse events (pulmonary infection, weight loss, etc.); (4) secondary outcome indicators: evaluation of psychological status, including the Hospital Anxiety and Depression scale (HADS), the Self-Rating Anxiety Scale (SAS), Self-Rating Depression Scale (SDS); and evaluation of quality of life, including the University of Washington Quality of Life Questionnaire version 4 (UW-QoL v4), Functional Assessment of Cancer Therapy – Head and Neck (FACT-H&N); and (5) type of study: randomized controlled trials (RCTs) or quasi-experimental studies.

Exclusion Criteria

The following types of study were excluded: (1) non-Chinese or non-English literature; (2) < 10% of oral cancer surgery patients in the study population; (3) study protocols; (4) repeat publications; or (5) full text not available.

Literature Search Strategy

Based on the PICOS principle and an initial search of the Cochrane Library, PubMed, Embase and CNKI, we identified the search strategy. The main search terms included oral neoplasms, postoperative, dysphagia and intervention. Using a combination of subject words and keywords, the databases we searched included PubMed, Embase, Web of Science Core Collection, CINAHL, Cochrane Central Register of Controlled Trials, CNKI, Wanfang and SinoMed. The search time frame was from database inception to 15 June 2021. In addition, we scanned the reference lists of all accepted reports for additional relevant studies. Online Appendix 1 provides examples of the specific database search strategies used with PubMed and CNKI.

Study Selection

The retrieved studies were imported into Endnote X9. Duplicate studies were removed. The titles and abstracts of the studies were searched and those that were not relevant were excluded. The full text was then read to determine whether the study should be included or not according to the inclusion and exclusion criteria. The selection of studies was conducted independently by two raters back-to-back and any discrepant ratings in the results were resolved through discussion or consultation with a third rater.

Quality Assessment

The methodological quality of each accepted RCT was assessed according to the Cochrane Handbook Version 5.1.0 [20]. The handbook addresses seven domains: random sequence generation; allocation concealment; blinding of participants and personnel; blinding of outcome assessment; incomplete outcome data; selective outcome reporting; and other issues. The appraisal instrument of the quasi-experimental study developed by the Joanna Briggs Institute Evidence-based Health Care Center in 2016 was used to evaluate the accepted quasi-experimental studies [21]. The tool includes nine entries on the comparability of the baseline, the description and analysis of loss to follow-up and the credibility of outcome indicator measures. Each are rated using yes, no, unclear and not applicable. The quality of the accepted studies was evaluated independently by two raters.

Data Extraction

Data were extracted using self-designed forms that included author, year of publication, country, type of study design, sample size, tumour site, tumour stage, type of intervention and control. One rater extracted the data and another checked the accuracy of the extracted data.

Statistical Analysis

Studies were grouped for analysis according to the measurement tools they used, starting point of intervention and outcome measurement time point. RevMan5.3 was used for the meta-analysis. Because this study only involved continuous outcomes, the mean difference (MD) or standard mean differences (SMD) were used to express the effect sizes, and the results were given as point estimates and 95% confidence intervals (CIs). The heterogeneity was estimated using chi-square test. When $P \geq 0.1$ and $I^2 < 50\%$, homogeneity was considered to exist and a fixed effect model was used to calculate the effect size. Otherwise, when $P < 0.1$ and $I^2 \geq 50\%$, heterogeneity was considered to be present and a random effect model was used.

Results

Search Outcome

A total of 3696 records were retrieved from the electronic databases. Of these, 1108 duplicates were removed, leaving 2588 remaining. After screening the title and abstract, obviously irrelevant records were removed, leaving 50 records remaining. After further reading of the full text, 10 articles were finally included [22–31]. Among them, six were in Chinese and four in English. The list of references was searched manually, and no other studies that could be included were found. The literature screening process is shown in Fig. 1.

Study Characteristics

This systematic review included 10 studies (4 RCTs [22, 23, 27, 29] and 6 quasi-experimental studies [24–26, 28, 30, 31]) involving 588 participants. One study was conducted in Turkey [23] and the rest in China. The number of participants ranged from 22 [23] to 148 [26], mainly adult males, with an age range of 28 [25] to 87 [31] years and a mean age ranging from 55.60 [22] to 72.86 [31] years. The tumour site and stage of oral cancer varied between studies. Most studies focused only on tongue cancers [24–27, 30, 31], followed by all oral cancers [22, 28, 29], and one study focused specifically on post-total maxillary maxillectomy [23]. Regarding cancer staging of participants, most studies reported all stages, namely I, II, III and IV, with the highest proportion at stages II–III [22, 24–28, 30, 31]. The primary surgical

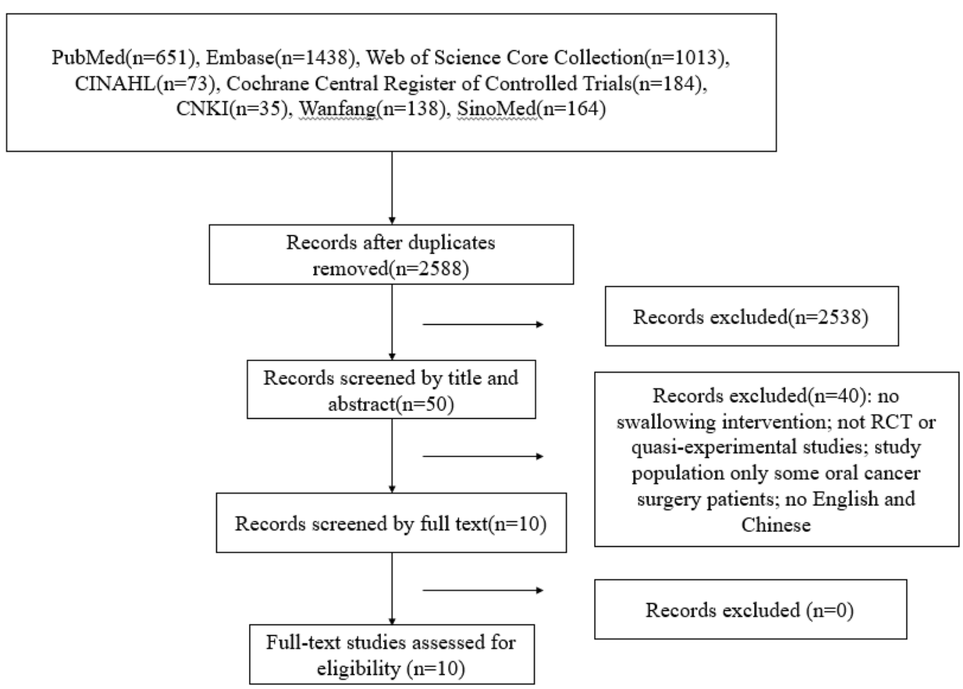

Fig. 1 Flowchart of the literature selection

approaches were extended resection and neck dissection, and tissue flap transfer repair. The proportion of lingual resections ≥ 50% versus < 50% was approximately the same, but the proportion with marginal resection of the mandible was significantly higher than segmental resection [24–27]. The methods of neck dissection were reported in four studies [24–27], but the choice of dissection varied widely between unilateral or bilateral (see Table 1).

Intervention Characteristics

Differences in starting point, frequency and duration of swallowing interventions were found across studies (Table 2). In most studies [22, 27, 28, 30, 31] intervention was started soon after operation; however, four studies [24–26, 29] did not specify the starting point. The earliest point for beginning intervention was the second day after operation [27], and the latest intervention was started within 3 weeks after operation [22]. Sezgin et al. [23] used xanthan gum-based fluid thickener to improve swallowing function, which began when patients could eat through the mouth.

Swallowing training time varied, including 30 min ($n=4$) [24–26, 28], 10–15 min ($n=1$) [30], 20–30 min ($n=1$) [27], 35–40 min ($n=1$) [29], or unspecified ($n=3$) [22, 23, 31]. The most common frequency of training was daily ($n=3$) [24, 30, 31], and other included 6 days/week ($n=2$) [25, 26], 2 times/day ($n=2$) [28, 29], 1–3 times/day ($n=2$) [26, 27], 3 times ($n=1$) [22] and unspecified ($n=1$) [23].

The duration of the whole training process also varied; short-term training was generally 7 days [28], 10 days [24, 27] or 2 weeks [25, 26], long-term training was mostly 3 months [22, 23, 31] or 4 months [30]. Only one study [29] did not clearly indicate duration of treatment.

Types of Swallowing Training

The types of swallowing training varied across the studies (Table 2). We categorized the training methods into four types.

Oral Exercise Training

Nine studies [22, 24–31] included oral exercise training, which mainly involved range of motion exercises and muscle strength training of lips, cheeks, tongue and mandible, with two of the studies [22, 31] focused on the effects of exercise training. Lip and cheek exercise training included lip-closure training [28, 29], mouth opening training [22], spatula-assisted resistance exercises for lips [31], cheek massage [28, 31] and chewing exercises with a chewing stick [31]. Tongue and mandibular movements were divided into active and passive training. The active training of the tongue was mainly carried out by the patients independently, and included tongue jacking (pressing the tip of the tongue against the left and right cheeks alternately), tongue curling, tongue extension, tongue retraction, tongue licking and sucking around the lips [22, 28–30]. Passive training referred to assistance or resistance movements with the help of tongue depressors, tongue aspirators and wet gauze [22, 28–31]. Mandibular active training included mandibular protrusion and lateral movement, oral lateral movement and open-mouthed chewing movement [22, 28, 29], and passive training included impedance training with the help of external force or a chewing tube [31]. In addition, there were studies that instructed patients to perform empty swallowing training (swallowing saliva with no food in the mouth) prior to exercise training [27, 30]. Four studies [24–27] only reported oral exercise training for patients, but did not specify the content.

Oral Sensory Stimulation

Six studies reported using oral sensory stimulation for patients. Of these, three [24–26] used thermal stimulation for patients with delayed swallowing reflex triggers; one study [28] used both temperature and olfactory stimulation for patients without specifying the exact method; and one study [29] used cold-acid to stimulate the soft palate, palatal arch, tongue root and posterior pharyngeal wall to strengthen the swallowing reflex. Another study [27] indicated only the use of oral sensory training.

Compensatory Strategies

Compensatory strategies mainly included posture modification and the adjustment of feeding tool and diet. Nine studies [22–27, 29–31] used this approach, two of which specifically explored the impact of dietary management: Liu et al. [29], who studied the impact of detailed dietary management and Sezgin et al. [23], who studied the impact of liquid viscosity. Dietary adjustments were mainly made by using thickening agents such as xanthan gum to adjust the consistency of liquids [23], choosing appropriate food texture and mouthful according to the swallowing ability of the patient, or strictly defining the speed and interval between meals [22, 24–27, 29–31]. Eight studies [22, 24–27, 29–31] restricted eating position and eating posture, mostly in a semi-Fowler 's position or sitting position, and selected effective eating posture training for patients according to symptomatic features of dysphagia. Two studies [30, 31] instructed patients to adapt their eating tools by using spoons with blunt, thick edges. It should be noted that only two studies [29, 31] described selection processes for food texture and eating posture, with most studies [22, 24–27, 30] not providing these details.

Table 1 Characteristics of the studies

Author	Design	Tumour site(s)	Group	Sample size	Male/female	Mean age	Age range	Tumour stage	Tongue rehabilitation	Neck dissection	Mandibulectomy resection	Reconstruction
Cheng et al	Q	Tongue	I(C)	74 (74)	46/28 (43/31)	61.27 ± 6.69 (59.59 ± 5.21)	NR	I:10(9), II:16(18), III:35(32), IV:13(15)	$\geq 50\%$:35(38), $< 50\%$:39(36)	Unilateral:22(25) Bilateral:11(13)	Segmental:16(20) Marginal/preserved:58(54)	NR
Huang et al	R	Tongue	I(C)	67 (67)	NR	NR	≥ 60:38(33) < 60:29(34)	I:4(6), II:24(21), III:30(28), IV:9(12)	$\geq 50\%$:37(32) $< 50\%$:30(35)	Unilateral:25(21) Bilateral:42(46)	Segmental:32(36) Marginal/preserved:35(31)	Free flap:35(29), Pedicled flap:33(38)
Jiang et al	Q	Tongue, Buccal, Gum, Mouth floor, Hard palate,	I	31	24/7	60.50	42 ~ 81	I:11, II:11, III:7, IV:2	NR	NR	NR	Non-skin flap: 6 Pedicled flap:18 Local flap: 5 Free flap: 2
Shi et al	Q	Tongue	I(C)	25(34)	15/10 (20/14)	56.47 ± 5.46 (55.78 ± 5.84)	NR	II:20(26), III:5(8)	NR	NR	NR	Free flap
Shi et al	Q	Tongue	I(C)	12(12)	9/3 (8/4)	55.60 ± 2.40 (53.30 ± 2.70)	43 ~ 72 (41 ~ 70)	NR	NR	NR	NR	Free flap
Liu et al	R	Salivary gland, Oropharynx, Gum, Tongue, Lip, Jaw bone,	I(C)	33(3)	17/16 (15/18)	55.94 ± 8.43 (55.56 ± 7.72)	39 ~ 72 (55 ~ 79)	NR	NA	NR	NR	NR
Hsiang et al	R	Buccal, Tongue, Lip, Gum, Retromolar, Hard palate, Mouth floor, Tonsil	I(C)	25(25)	24/1 (24/1)	55.60 ± 8.60 (56.70 ± 9.00)	43 ~ 70 (40 ~ 76)	I:4(6), II:5(4), III:7(3), IV:9(12)	NA	NR	NR	Pedicled flap:13(5), Free flap:12(19), Local flap:0(1)
Sezgin et al	R	Maxilla	I(C)	12(10)	7/5 (5/5)	56.66 ± 9.87 (60.10 ± 15.63)	NR	NR	NA	NR	NR	NR
Zhang et al	Q	Tongue	I	58	43/15	56.60	40 ~ 81	I:9, II:23, III:21, IV:5	$\geq 50\%$:28 $< 50\%$:30	Unilateral:28 Bilateral:30	Segmental:23 Marginal/preserved:35	Free flap:22, Pedicled flap:36
Zhen et al	Q	Tongue	I(C)	23(23)	17/6 (14/9)	60.52 ± 5.55 (57.47 ± 5.72)	28 ~ 71	I:3(3), II:5(5), III:11(10), IV:4(5)	$\geq 50\%$:10(9) $< 50\%$:13(14)	Unilateral:7(8) Bilateral:5(4)	Segmental:5(6) Marginal/preserved:18(17)	Free flap:9(8), Pedicled flap:14(15)

Table 2 Swallowing training measures included in the study

Author, year	Intervention	Control	Intervention start time	Intervention duration	Frequency	Time	Outcome measures
Cheng et al. (2019)	①+②+③+④	⑤	–	2 weeks	1 ~ 3 times/6 days/week	30 min	Functional: EAT-10; QOL: UW-QoL v4; other: Chinese Speech Intelligibility Word List;
Huang et al. (2017)	①+②+③+④	⑤	10 days after surgery	10 days	1 ~ 3 times/day	20 ~ 30 min	Functional: EAT-10; QOL: FACT-H&N
Jiang et al. (2018)	①+②+④	n/a	2 days after surgery	7 days	2 times/day	30 min	WST, MASA-C, VFSS
Shi et al. (2019)	①+③	⑤	5 days after surgery	4 months	Daily	10 ~ 15 min	Functional: WST; QOL: UW-QoL v4; other: Chinese Speech Intelligibility Word List;
Shi et al. (2019)	①+③	③	8 days after surgery	3 months	Daily	–	Functional: WST
Liu et al. (2019)	①+②+③+④	①+②+④	–	–	2 times/day	35 ~ 40 min	Functional: WST, VFSS, aspiration events; nutrition: BMI, Serum albumin level; QOL: UW-QoL v4; other: compliance
Hsiang et al. (2019)	①+③	③	Within 3 weeks after surgery	3 months	3 times/day	–	Functional: MBSS, PAS
Sezgin et al. (2019)	③	⑤	When fluid food is available	3 months	–	–	Functional: EAT-10, FOSS, FOIS; nutrition: BIA; QOL: MDADI;
Zhang et al. (2014)	①+②+③+④	n/a	–	10 days	Daily	30 min	Functional: WST; other: SDS
Zhen et al. (2012)	①+②+③+④	⑤	–	2 weeks	6 days/week	30 min	QOL: MDADI

① Oral exercise

② Oral sensory stimulation

③ Surrogate training

④ Protective airway manoeuvre

⑤ Routine health education, – indicates not detailed, n/a indicates not applicable

QOL quality of life, *MASA-C* Mann Assessment of Swallowing Ability-Cancer, *BMI* Body mass index, *MBSS* Modified Barium Swallow Study, *PAS* Rosenbek Penetration-Aspiration Scale, *FOSS* Functional Outcome Swallowing Scale, *FOIS* the Functional Oral Intake Scale, *MDADI* the MD Anderson Dysphagia Inventory, *BIA* Multifrequency bioimpedance analysis

Protective Airway Manoeuvres

Seven studies [24–30] used protective airway manoeuvres in patients with choking and aspiration. These included supraglottic swallow, Mendelssohn manoeuvre and effortful swallow. One study [26] used the Mendelssohn manoeuvre, three studies [27, 29, 30] used supraglottic swallow, one study [28] applied both supraglottic swallow and Mendelssohn manoeuvre, and the other two studies [24, 25] used all three methods together.

Outcomes

Outcome indicators were reported as follows: the safety and/or efficiency of swallowing function, quality of life, psychological status, nutritional status, speech intelligibility and complications (Table 2).

Swallowing Function

The most commonly used assessment tool for swallowing function was the WST ($n = 5$) [24, 28–31], followed by

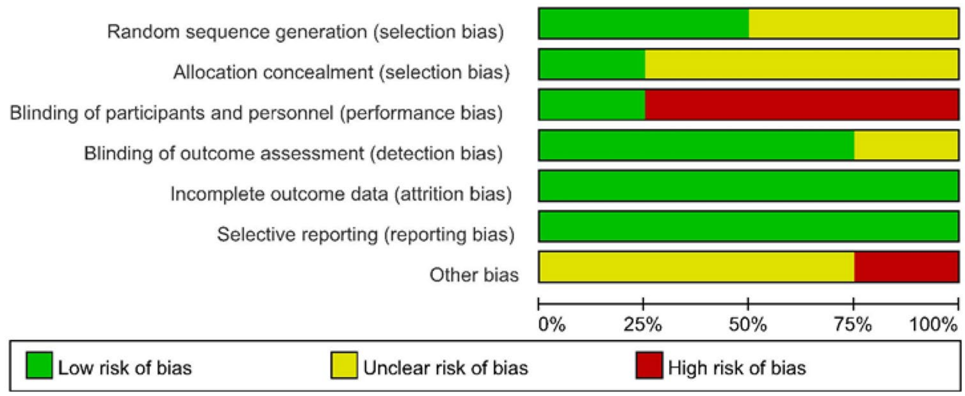

Fig. 2 Risk of bias graph of included studies (randomized controlled trials)

the EAT-10 ($n=3$) [23, 26, 27]. The gold standard for the assessment of dysphagia, VFSS, was used in two studies [28, 29] to further identify complications such as aspiration and leakage or to observe and calculate pharyngeal shrinkage rate when eating diets of different textures. One study [22] used both barium swallow study (MBSS) and PAS to assess the safety of swallowing and to examine oral and pharyngeal residues. In addition, other tools used in combination included the MASA-C ($n=1$) [28], FOSS ($n=1$) [23], and FOIS ($n=1$) [23].

Quality of Life

The quality of life of patients was assessed with the UW-QoL v4 ($n=3$)[26, 29, 30], MDADI ($n=2$) [23, 25], or FACT-H&N ($n=1$) [27]. Among them, the UW-QoL v4 and MDADI were both used to evaluate the short-term effects (about 2 weeks after surgery) and long-term effects (3 months after surgery). The FACT-H&N was only used for short-term effect evaluation in the included studies.

Others

In addition, various other outcome indicators were reported. The Chinese Speech Intelligibility Word List was used in two studies [26, 30] to report on speech intelligibility. In one study [23], multifrequency bioimpedance analysis (BIA) was used to measure changes in nutritional status such as body mass index (BMI), waist circumference and hip circumference, and another [29] reported BMI, serum albumin level and complications (such as flap necrosis, wound bleeding, infection and aspiration). Psychological status was reported using the SDS in one study [24].

Quality Appraisal of the Included Studies

The four RCTs [19, 20, 24, 26] used randomization, with two studies [19, 26] using a random number list and the other two studies [20, 24] having unclear grouping. The risk of implementation bias was high as the intervention was difficult to blind to the investigator and subjects. A blinding method was applied to the outcome evaluators in three studies [19, 20] and the outcome index of one study [24] was a patient self-assessment tool, which makes the risk of bias low. One study [26] did not introduce outcome evaluators. Other risks of bias were unknown for three studies [19, 20, 26] and the risk of bias was high for one study [24] with unclear baseline characteristics. Two quasi-experimental studies [22, 28] measured outcome indicators only after the intervention, and one study [28] used inappropriate methods for data analysis (see Figs. 2, 3; Table 3).

Effects of Swallowing Training

Effects on Swallowing Function

Although the WST is the most used evaluation tool, because of the differences in types of design and training methods of each study, we chose the EAT-10 to calculate effect size. A total of 304 subjects were enrolled [22, 23, 26]. Owing to differences in training duration, we divided the measurement results into short-term effect (about 2 weeks after surgery) and long-term effect (3 months after surgery). A fixed effect model was used ($I^2=0\%$, $P=0.78$). The swallowing function of the intervention group was better than that of the control group in the short term after surgery, and this difference was statistically significant [MD $=-2.67$, 95%CI ($-4.22, -1.12$), $Z=3.38$, $P<0.01$]. However, intervention had no effect on long-term swallowing function [MD $=-2.43$, 95%CI ($-7.39, -2.53$), $Z=0.96$, $P>0.01$] (see Fig. 4).

Effects on Quality of Life

Three studies [26, 29, 30] used the UW-QoL v4 to evaluate the quality of life of postoperative patients. One study [29] did not specify the time point of evaluation, so only two of the studies [26, 30] were included. The evaluation point of 2 weeks after surgery was selected to calculate effect size, and a total of 207 subjects were included [26, 30]. A random effect model was used because of heterogeneity ($I^2 = 89\%$, $P < 0.01$). The results showed that swallowing training could improve the quality of life of postoperative patients [MD = 84.96, 95%CI (51.02, 118.90), $Z = 4.91$, $P < 0.01$] (see Fig. 5).

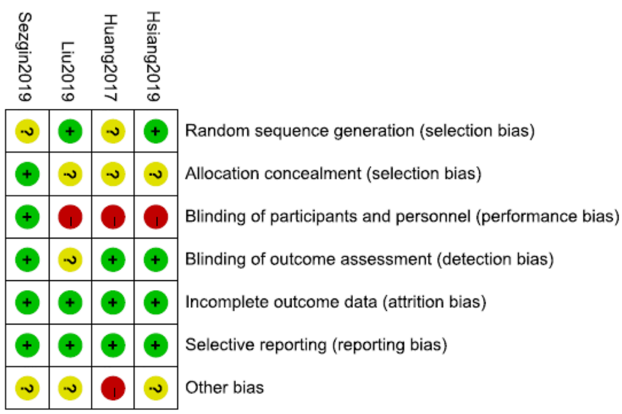

Fig. 3 Risk of bias summary of included studies (randomized controlled trials)

Discussion

Our study identified 10 intervention studies. Through a systematic review of the swallowing training measures for postoperative oral cancer patients, four intervention methods were summarized: oral exercise, oral sensory stimulation, compensatory strategies and protective airway manoeuvre. At present, no systematic review of swallowing training measures specifically for postoperative patients with oral cancer has been performed. Our study found that many types of swallowing training measures for postoperative oral cancer patients are used, primarily in combination. The training contents varied widely among study designs, and there were significant differences in the start time, frequency and duration of interventions.

Oral exercise training is widely used to increase the motor strength, stability and coordination of various organs, muscles and tissues, improving chewing ability, reducing salivation and improving oral control of the bolus freehand or with the help of some simple tools [4]. Hsiang et al. [22] used a barium swallow study (MBSS) to observe the effect of oral motor training on swallowing function in patients with oral cancer, 1 month after surgery. The exercise group had significantly less oral and pharyngeal residue after 3 months compared with the control. Shi et al. [31] conducted oral exercise training for postoperative patients with tongue cancer for 3 months, and showed that oral exercise was effective in improving swallowing function, with training starting on the eighth postoperative day. Both studies suggested that oral motor training could improve swallowing function with

Table 3 Risk of bias summary of included studies (quasi-experimental studies)

Author, year	1	2	3	4	5	6	7	8	9
Cheng et al. (2019)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Jiang et al. (2018)	Yes	Not applicable	Not applicable	Yes	Yes	Yes	Yes	Yes	Yes
Shi et al. (2019)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Zhang et al. (2014)	Yes	Not applicable	Not applicable	Yes	Yes	Yes	Yes	Yes	Yes
Zhen et al. (2012)	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes
Shi et al. (2019)	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	No

1 Is it clear in the study what is the "cause" and what is the "effect" (i.e. there is no confusion about which variable comes first)?

2 Were the participants included in any comparisons?

3 Were the participants included in any comparisons receiving similar treatment/care, other than the exposure or intervention of interest?

4 Was there a control group?

5 Were there multiple measurements of the outcome both pre and post intervention/exposure?

6 Was follow-up complete and, if not, were differences between groups in terms of their follow-up adequately described and analysed?

7 Were the outcomes of participants included in any comparisons measured in the same way?

8 Were outcomes measured in a reliable way?

9 Was appropriate statistical analysis used?

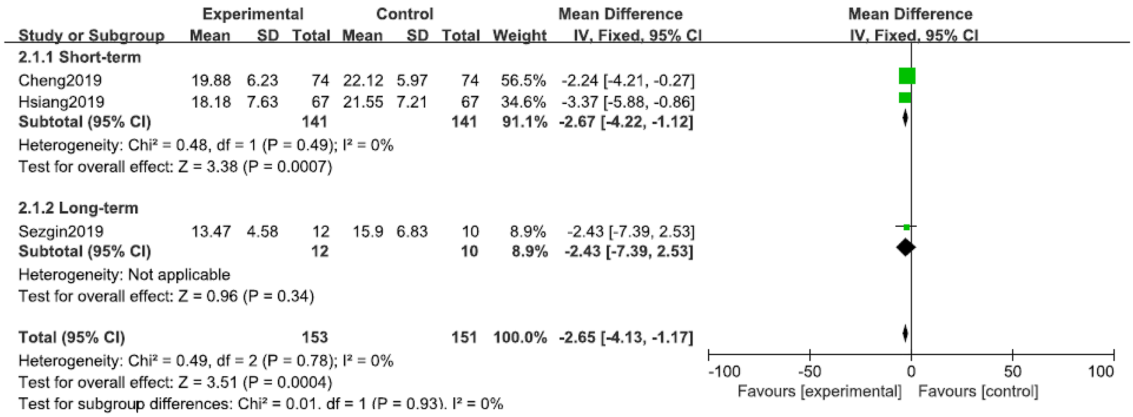

Fig. 4 Effects on swallowing function

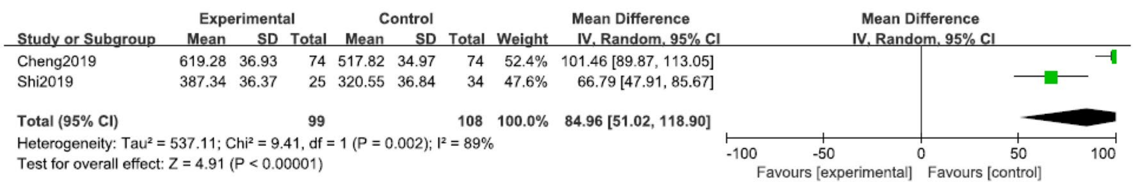

Fig. 5 Effects on quality of life

significant efficacy, but the timing of the start was more controversial and needed further studies and exploration.

Oral sensory stimulation comprises a series of training measures designed for deep and superficial oral sensation and perception, and for abnormal swallowing reflex [4]. In the included studies, oral sensory stimulation mainly focused on temperature stimulation, olfactory stimulation and cold-acid stimulation. Temperature stimulation, including thermal and cold stimulation, can increase the patient's sensitivity to the perception of bolus and enhance sensory afferents [32, 33]. Most of the studies included in this paper used thermal stimulation, but some studies have shown that only thermal stimulation had no significant effect on swallowing, whereas alternating the application of thermal stimulation with cold stimulation dilated capillaries and increased blood circulation. This differs from the results of our study, which may be related to the combined application of training measures and ignoring the clinical effects of various measures. Olfactory stimulation refers to the use of small molecules in aromatic substances to stimulate the sense of smell and promote the regulation of smell and information transmission, thus restoring the sensitivity of the swallowing reflex [4]. A RCT [34] using black pepper oil in elderly patients with swallowing disorders found that this method could accelerate the initiation of swallowing and improve its safety. Cold-acid stimulation combines cold stimulation with acid stimulation to strengthen oral muscle function and a throat reflex. Wang et al. [35] applied this method to 70 patients with dysphagia after stroke and found a significant improvement in swallowing function and a significant reduction in the incidence of aspiration pneumonia and malnutrition in the treatment group.

The use of compensatory strategies can improve the safety and effectiveness of swallowing. In our study, two studies [23, 29] focused on the effects of dietary management and other methods on swallowing function. The studies showed that these methods not only increased the pharyngeal contraction rate when swallowing clear fluid and a concentrated fluid diet, but also improved dysphagia. These methods can also improve nutritional status, reduce the incidence of aspiration and other complications, and improve quality of life. Consistent with the findings of Taniguchi et al. [36], food hardness influenced the total swallowing time and oral transport time, and food consistency influenced pharyngeal transport time. Solazzo et al. [37] used video-fluorometric manometry to find that postural adjustments could improve or eliminate aspiration in patients with swallowing disorders.

Protective airway manoeuvres can reduce choking and aspiration by increasing the range and strength of movement of oral organs or muscles. The Mendelssohn manoeuvre can improve the duration and amplitude of laryngeal elevation and increase the opening degree and time of the cricopharyngeal muscle by passively lifting the larynx [4]. Using high-resolution manometry, Hoffman et al. [38] also found that the Mendelssohn manoeuvre could improve the safety and effectiveness of swallowing in specific situations.

Supraglottic swallowing is the closing of the airway before and during swallowing and coughing immediately after swallowing. It can significantly reduce the peak contraction of the upper oesophageal sphincter [39], which is simple and effective, and is currently one of the most widely used measures in postoperative patients with oral cancer. Effortful swallowing enhances the ability of the tongue root to move backwards during pharyngeal swallowing and reduces food residue in the epiglottis [4]. However, this method has been found to increase the risk of leakage and aspiration and should be used with caution [40].

Despite these methodological limitations, we pooled data on the effects of swallowing training on swallowing function and quality of life from studies with similar intervention start times and outcome measurement times. Through the meta-analysis, we found that swallowing training can improve patients' swallowing function and quality of life in the short term after surgery but long-term effect on swallowing function is not significant. Based on our analysis of this result, we put forward the following viewpoints. First, most patients in these 10 studies were in the middle or advanced stage of cancer [22, 24–28, 30, 31]. About 6 weeks after surgery, most of them needed to start receiving radiotherapy and chemotherapy [41], which would also aggravate swallowing disorders. Second, only one study [23] was on the long-term effect of swallowing function, with a small-sample size. In addition, the training duration in most of the studies was short, with training only conducted between 7 and 10 days after surgery [22, 24, 28], and the long-term effects need to be further studied. The training effects of individual measures were unclear, and further research is required to explore and compare the effects of combined application. A more targeted and effective standardized training programme for postoperative patients with oral cancer is necessary.

Swallowing training improves the efficiency of swallowing on the premise of ensuring the safety of swallowing, to improve quality of life. Therefore, safety should be the most important evaluation index of swallowing training. VFSS and MBSS are considered gold standard for the measurement of dysphagia [42], and their use enables direct observation of changes to food mass movement during the swallowing process and evaluation for leakage or aspiration. However, only three studies [22, 28, 29] used such tools, and only one study [29] measured aspiration and other complications. The tools used in other studies to measure swallowing function also vary. Therefore, more attention to the safety of swallowing training, the development of specific evaluation tools for swallowing disorders in oral cancer patients after surgery, and standardization of measurement methods and evaluation criteria are necessary.

This study had some limitations. Firstly, a systematic search identified a total of 10 relevant studies. The reason for the small number may be that studies on dysphagia in oral cancer include more patients who had radiotherapy and chemotherapy, and these were not included in our study. In addition, most of the included studies were small-sample, single-centre trials, with a small number of RCTs of low quality. In addition, the trial groups were mostly exposed to a combination of measures, so the treatment effects of individual measures were unclear and the descriptions of the training contents were not specific enough to be replicated. Therefore, we believe that more high-quality, large-sample, multi-centre RCTs should be conducted in the future to explore the effects of various training methods on swallowing function, to enable the formulation of individual, scientific, reasonable and evidence-based intervention programmes that can be replicated in clinical practice.

Conclusions

This systematic review summarizes swallowing training methods for postoperative patients with oral cancer in four areas: oral exercise, oral sensory stimulation, compensatory strategies and protective airway manoeuvres. We conducted a meta-analysis of similar studies, and the results showed that swallowing training could improve patients' swallowing function and quality of life in the short term after surgery but the long-term effects on swallowing function were not obvious, and further research is necessary. In addition, our study found that current training measures are used primarily in combination, so the effectiveness of individual measures is still unclear and the optimal duration of training remains controversial. Therefore, a high-quality RCT on the clinical applicability and efficacy of various training measures is necessary, to explore the effectiveness of each training measure and specific implementation programmes, to provide a theoretical basis for clinical practice.

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