

Early Swallowing Rehabilitation After Oral Cancer Surgery: Pooled Evidence From a Quantitative Systematic Review

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Article info

Abstract

Postoperative difficulty in swallowing commonly develops after operations for oral malignancies and can affect nutritional intake, respiratory safety, and overall quality of life. This study quantitatively synthesized randomized-trial evidence to assess if initiating rehabilitation shortly after surgery enhances recovery of swallowing function and associated life-quality measures. Seven Chinese and international databases, including CNKI, WanFang, VIP, CBM, PubMed, Embase, and the Cochrane Library were searched from database launch through May 2026. Only randomized controlled trials comparing early rehabilitation with standard postoperative care were included. Nine trials involving 838 patients were included. Early rehabilitation was associated with better WST, EAT-10, and MASA-OC outcomes at the reported follow-up points, and it also improved the swallowing domain of the UW-QOL. Swallowing therapy initiated within the first one to two weeks following surgery may support functional swallowing recovery and better swallowing-related quality of life. Because several included studies had incomplete reporting of randomization, allocation concealment, and blinding, the conclusion should be interpreted as supportive rather than definitive.

Keywords:: Early Rehabilitation Training; Postoperative Oral Cancer; Swallowing Function; Quality of Life; Meta-Analysis

1. Introduction

Oral cancer remains a major global health problem. Recent epidemiological data show that new cases have exceeded 400,000 annually and that deaths are close to 180,000, with surgery still serving as a central treatment for resectable tumors [1]. Although radical resection combined with free-flap reconstruction can restore structural defects, the operation may affect the tongue, mouth floor, pharyngeal muscles, and neuromuscular control of swallowing. Postoperative dysphagia can then interfere with oral intake, nutritional support, aspiration prevention, tolerance of adjuvant

treatment, and quality of life [2]. For this reason, swallowing recovery should be regarded as an essential component of perioperative functional management in oral cancer care.

Early rehabilitation offers a feasible way to reduce these functional impairments. Reported programs include swallowing exercises, feeding instruction, oral sensorimotor stimulation, and individualized functional training, all of which may improve swallowing performance and patient-reported outcomes [3-8]. However, the immediate postoperative period is also characterized by edema, wound repair, pain, drainage, and risks such as fistula or wound dehiscence. The timing and intensity of training therefore need careful adjustment [9][10]. Existing studies differ in start time, intervention frequency, training content, and outcome measures. A pooled analysis is needed to clarify whether early postoperative rehabilitation provides consistent benefits after oral cancer surgery.

2. Study Methods

2.1 Retrieval Strategy

We systematically searched CNKI, WanFang, VIP, CBM, PubMed, Embase, and the Cochrane Library, covering the period from database launch to May 2026. Subject headings and free-text words were combined. Chinese search terms covered oral malignant tumors, postoperative status, rehabilitation, and swallowing, while English terms included oral cancer, postoperative care, dysphagia, rehabilitation, and quality of life. The strategy linked disease-related terms, postoperative-context terms, rehabilitation or swallowing terms, and randomized-trial filters. Table 1 lists the detailed search examples for CNKI and PubMed.

Table 1 Search strategies

Database	Search strategy
CNKI	Oral neoplasm/tongue cancer terms AND postoperative/perioperative terms AND rehabilitation/swallowing/quality-of-life terms AND randomized-trial terms.
PubMed	(Mouth or tongue neoplasm terms) AND (postoperative care/period terms) AND (rehabilitation, dysphagia, swallowing disorder, or quality-of-life terms).

2.2 Eligibility Criteria

Reports were eligible when they satisfied the following criteria: (1) they were randomized controlled trials; (2) participants were adults aged 18 or older who had undergone surgery for primary oral cancer, irrespective of gender or ethnicity, and had no psychiatric conditions, allowing them to engage in rehabilitation; (3) the intervention involved an early rehabilitation protocol designed to enhance swallowing function or quality of life, whereas the comparison group received routine postoperative care or an alternative non-rehabilitation method; and (4) outcomes evaluated swallowing functions via tools like the Water Swallow Test (WST), EAT-10, or MASA-OC, together with quality-of-life evaluation using the University of Washington Quality of Life Questionnaire (UW-QOL). Studies were excluded when they were non-randomized, duplicated, unavailable in full text, or involved rehabilitation that began more than one month after surgery or during postoperative radiotherapy or chemotherapy. Reports were also excluded if outcome definitions were unclear, numerical data were absent or obviously incorrect, or if neither swallowing function nor quality-of-life outcomes were reported.

2.3 Study Selection and Data Collection

All database records were imported into NoteExpress and duplicates were removed. Two

reviewers first screened titles and abstracts independently and then reviewed the full texts that appeared eligible. Any discrepancies were settled after consultation with a third reviewer. The data sheet recorded the first author, publication year, design type, tumor site, sample size, demographic details including sex and age, timing of rehabilitation commencement, intervention specifics, and reported results.

2.4 Risk-of-Bias Assessment

The randomized-trial risk-of-bias framework recommended in the Cochrane Handbook 5.1, was applied to assess the methodological quality. Key areas evaluated were sequence generation, concealment of allocation, blinding of participants and staff, blinding of outcome assessment, completeness of outcome data, selective outcome reporting, and other possible sources of bias. Two reviewers judged each domain independently as low, high, or unclear risk, and disagreements were resolved through consultation with the corresponding author.

2.5 Data Synthesis

RevMan 5.3 was used to perform the quantitative analysis. All outcomes were continuous, so summary effects were reported as mean differences (MDs) or standardized mean differences (SMDs), each with a 95% confidence interval (CI). SMD was selected for the Water Swallow Test (WST) due to its ordinal nature and potential variability in scoring across studies. MD was used for EAT-10, MASA-OC, and UW-QOL, as these scales had consistent scoring systems. Between-study heterogeneity was assessed with the chi-square test ($\alpha = 0.10$) and the I^2 value. Fixed-effect pooling was used for low heterogeneity, and random-effects pooling was used when heterogeneity was evident. Subgroup or sensitivity analyses were performed when necessary, and outcomes with considerable unexplained heterogeneity were presented in narrative form.

3 Findings

3.1 Search Yield

The database search initially identified 956 records. After removal of 585 duplicate records using NoteExpress, titles and abstracts were reviewed, leading to the full-text evaluation of 80 articles. Exclusions were primarily due to irrelevant populations, interventions not aligning with the inclusion criteria, mismatched outcomes, non-randomized study designs, and lack of original data, as depicted in Figure 1. Eventually, nine randomized trials were finally included, comprising 838 participants: 416 assigned to rehabilitation and 422 assigned to control care.

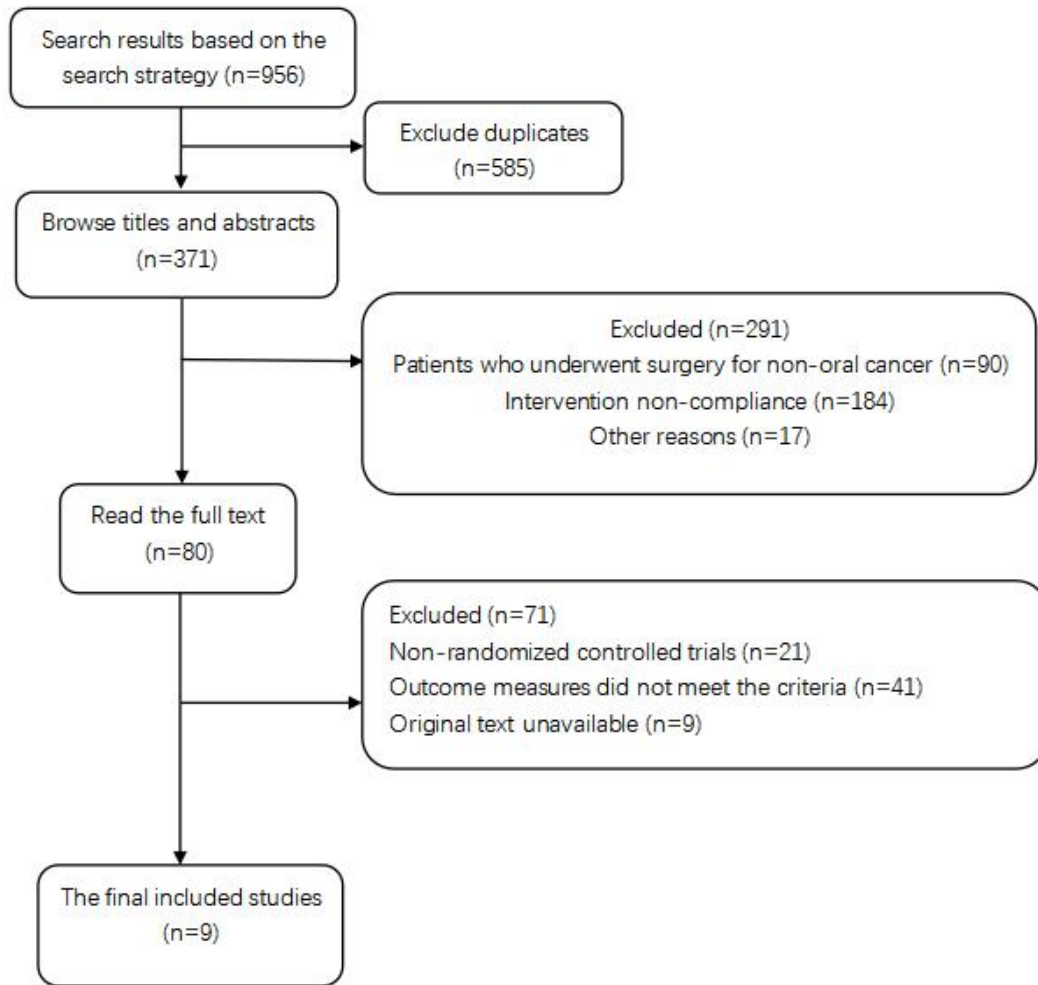


Figure 1 Literature search and eligibility-screening flowchart

Table 2 summarizes the main characteristics of the included trials. Rehabilitation began within one to two weeks after surgery in all studies, and most interventions used combined programs rather than a single training method. Overall, 553 participants were male (66.0%) and 285 were female (34.0%), with mean ages ranging from 49.0-61.5 years. Six trials focused on patients with tongue carcinoma [11-16], while three included other oral-cancer sites [17-19]. The evidence base is therefore concentrated mainly in tongue cancer but also provides limited information for broader oral-cancer populations.

Table 2. Summary of the included studies

Study	Tumor site	Sample size (T/C)	Sex (male/female)	Mean age (T/C)	Intervention start	Intervention (experimental group)	measures	Main outcomes
Bai 2022 [11]	Tongue	50/50	69/31	57.27/59.23	Postoperative day 5	Staged swallowing and feeding training: cold stimulation, dry swallowing, supraglottic swallowing, and tongue exercises.		a
Cheng 2019 [12]	Tongue	74/74	89/59	61.27/59.59	Postoperative day 1	Two-week direct/indirect swallowing therapy with Mendelsohn maneuver, thermal stimulation, and strength training.		b,d
Shi 2019 [13]	Tongue	25/34	35/24	56.47/55.78	Postoperative day 3	Progressive dry/saliva swallowing, chewing, tongue movement, and speech training.		a,d
Huang 2017 [14]	Tongue	67/67	96/38	61.5	Postoperative day 10	Ten-day swallowing training with postural/bolus control and lip-tongue sensorimotor exercises.		b
Tian 2017 [15]	Tongue	30/30	40/20	57.8/54.5	Postoperative day 3	Staged limb, swallowing, chewing, tongue, and speech rehabilitation.		a
Yu 2017 [16]	Tongue	30/30	36/24	49	Preoperative adaptive training; postoperative day 3	Perioperative guidance with preoperative adaptation and postoperative staged swallowing, chewing, tongue, and speech training.		a
Wu 2024 [17]	Mixed oral sites	62/59	84/37	49.5/51.5	Postoperative day 6	Multimodal sensory, active, and passive oral exercises; twice daily, 20-30 min per session.		c,d
Zhang 2022 [18]	Mixed oral sites	34/34	45/23	51.00/54.32	Postoperative day 6	Personalized MASA-OC-guided cold-acid, vibration, air-pulse, lip, and tongue training; twice daily for 10 days.		c,d
Zhang 2023 [19]	Mixed oral sites	44/44	59/29	51.72/52.68	Early postoperative period (inferred within 1 week)	Personalized oral sensory stimulation and lip-cheek, jaw, and tongue exercises; twice daily for 10 days.		c,d

Note: a, WST; b, EAT-10; c, MASA-OC; d, UW-QOL. Zhang et al. [19] did not specify the exact day on which rehabilitation began. Based on the reported nasogastric-tube removal time and the 10-day training period, the intervention was considered to have started during the first postoperative week. Cheng et al. [12] and Shi et al. [13] reported only total UW-QOL scores and were therefore excluded from the swallowing-domain pooled analysis.

3.2 Risk-of-Bias Evaluation

Figure 2 shows the bias appraisal across the nine trials. Four trials [14][17-19] reported specific randomization methods: three used random number tables [17-19], and one used stratified block randomization [14]. Two studies [12][16] mentioned random allocation but did not describe sequence generation, while three studies [11][13][15] were considered high risk because allocation was based on admission time. Allocation concealment was reported in two trials [17][18]. One trial [17] clearly stated that participants and personnel were not blinded, whereas blinding procedures were insufficiently described in most remaining studies. Attrition was low and the primary outcomes were reported completely.

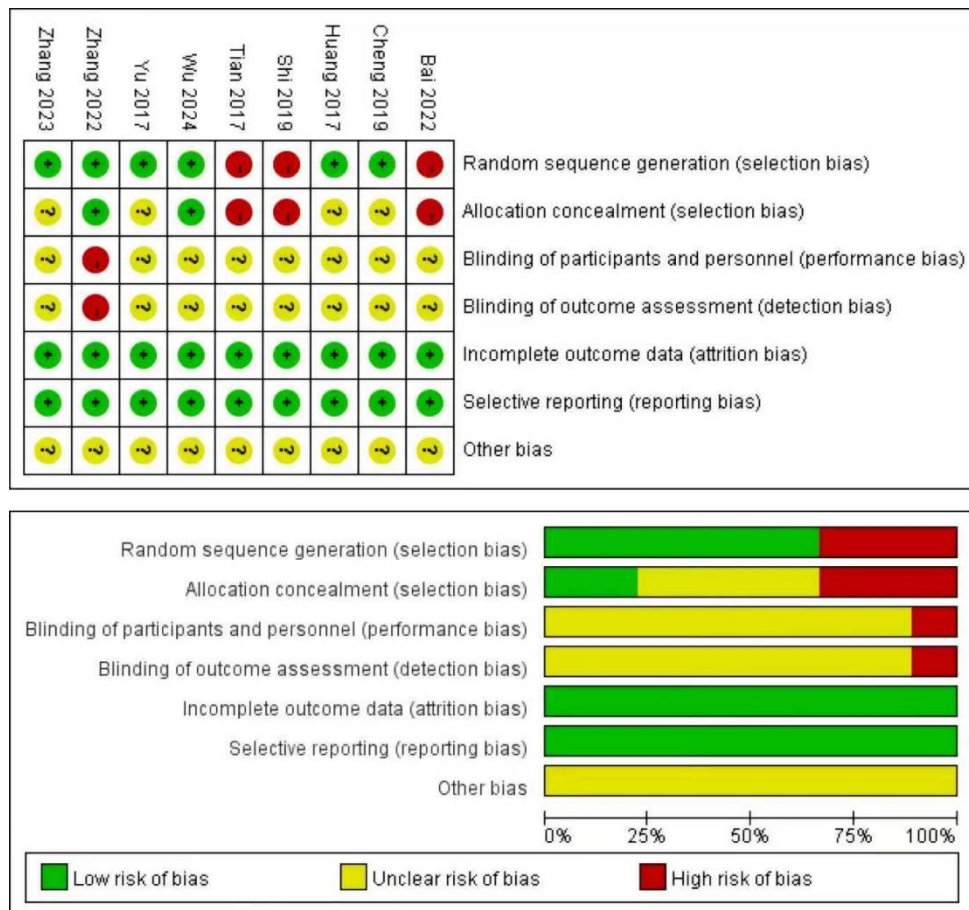


Figure 2 Risk-of-bias evaluation of the included trials

3.3 Pooled Analysis Results

3.3.1 WST Score

Four trials [11][13][15][16] with 288 participants reported WST outcomes, with equal numbers in the rehabilitation and control groups. No statistical heterogeneity was detected ($P = 0.43$, $I^2 = 0\%$). The combined analysis revealed a more larger decrease in WST scores among patients receiving rehabilitation than among controls [$SMD = -1.16$, 95% CI: -1.42 to -0.91 , $Z = 8.97$, $P < 0.00001$]. This is illustrated in Figure 3, all individual trials favored early rehabilitation, indicating consistent improvement for this outcome.

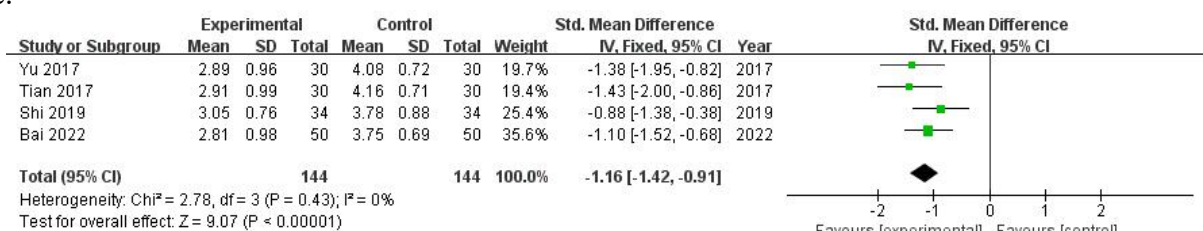
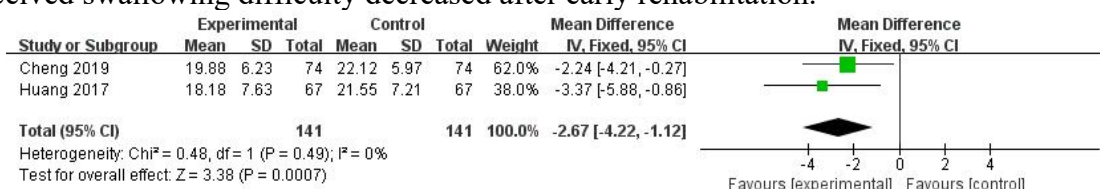


Figure 3 Meta-analysis of WST score improvement between the rehabilitation and control groups

3.3.2 EAT-10 Score

Two studies [12][14] involving 282 participants provided EAT-10 data. Both reported larger score reductions after early rehabilitation than after routine care. Because between-study heterogeneity was negligible ($P = 0.48$, $I^2 = 0\%$); therefore, fixed-effect pooling was used. The combined result indicated a between-group difference favoring rehabilitation [$MD = -2.67$, 95% CI: -4.22 to -1.12 , $Z = 3.39$, $P = 0.0007$]. Figure 4 shows that both studies supported the intervention effect, suggesting that patient-perceived swallowing difficulty decreased after early rehabilitation.



3.3.3 MASA-OC Score

Three trials [17-19] including 277 patients reported MASA-OC results. Assessments were conducted at approximately one week (6-7 days), two weeks (14-15 days), and one month after surgery. Subgroup analyses were therefore conducted according to assessment time, and Figures 5-7 display the pattern of swallowing recovery across these postoperative periods.

On days 6-7 post-surgery, marked heterogeneity was present ($P = 0.0008$, $I^2 = 86\%$), and the data were therefore pooled with a random-effects model. The early rehabilitation group showed higher MASA-OC improvement than the control group [MD = 7.25, 95% CI: 1.80 to 12.70, $Z = 2.61$, $P = 0.009$], as illustrated in Figure 5. Although the effect size differed among trials, the pooled estimate still suggested an early functional benefit.

At 14-15 days after surgery, heterogeneity was moderate ($P = 0.05$, $I^2 = 66\%$), so the random-effects model was used. MASA-OC scores remained higher in the early rehabilitation group [MD = 6.35, 95% CI (2.73, 9.97), $Z = 3.44$, $P = 0.0006$], as presented in Figure 6.

At one month postoperatively, heterogeneity was absent ($P = 0.54$, $I^2 = 0\%$), allowing use of the fixed-effect model. MASA-OC scores continued to favor rehabilitation over control care [MD = 10.28, 95% CI: 8.66 to 11.91, $Z = 12.39$, $P < 0.00001$], as shown in Figure 7. The one-month estimate was more stable and homogeneous than the earlier time-point estimates.

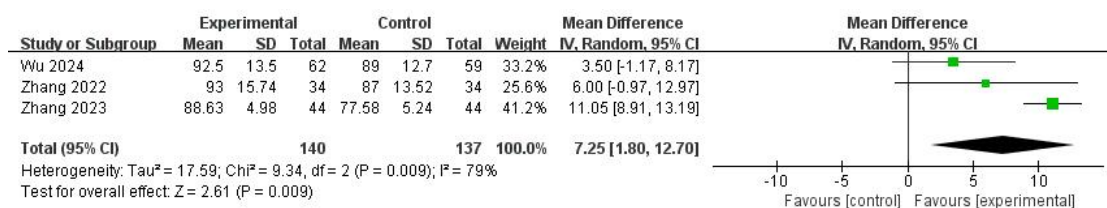


Figure 5 Meta-analysis of MASA-OC score improvement at one postoperative week

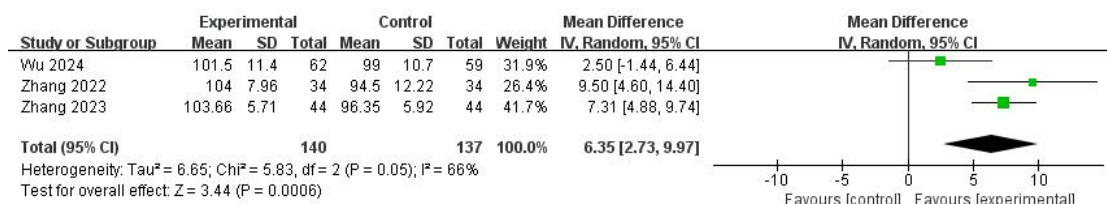


Figure 6 Pooled MASA-OC improvement at two postoperative weeks

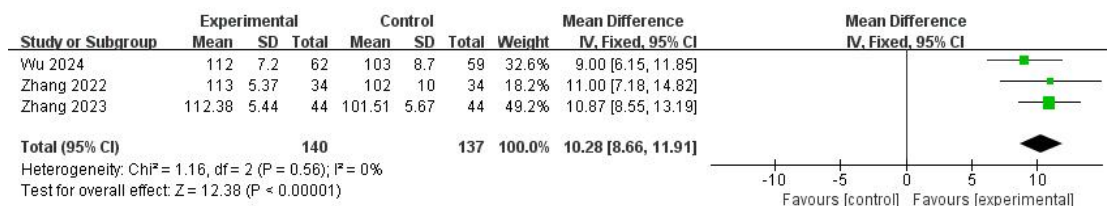


Figure 7 Pooled MASA-OC improvement at one postoperative month

3.3.4 UW-QOL Score

Three studies [17-19] involving 277 participants documented the swallowing-domain score of the UW-QOL. Heterogeneity was negligible ($P = 0.56$, $I^2 = 0\%$), so fixed-effect pooling was applied. The rehabilitation group had a higher swallowing-domain score than controls [MD = 23.18, 95% CI: 18.04 to 28.33, $Z = 8.83$, $P < 0.00001$]. Figure 8 shows that all three studies favored early rehabilitation, indicating that functional improvement was accompanied by better swallowing-related quality of life.

Only one trial [18] provided the overall UW-QOL score on the 0-100 scale. In that trial, the intervention group also showed a better overall quality-of-life result than controls, implying that early rehabilitation may have benefits beyond swallowing-specific domains.

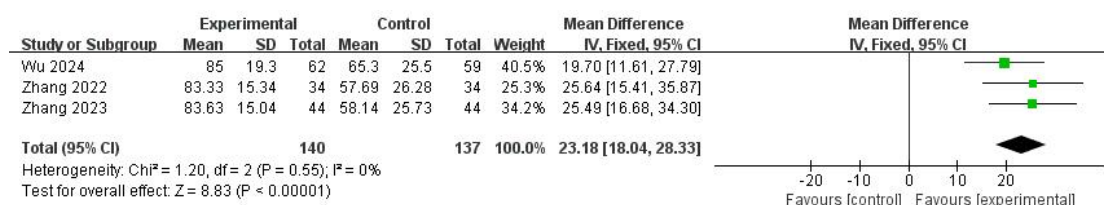


Figure 8 Meta-analysis of improvement in the UW-QOL swallowing-domain score

4. Discussion

This review pooled evidence on early rehabilitation for swallowing recovery and quality of life after oral cancer surgery. Across WST, EAT-10, MASA-OC, and the UW-QOL swallowing domain, rehabilitation initiated within one to two postoperative weeks was associated with more favorable outcomes than routine care. These results are consistent with recent systematic reviews and further support the inclusion of early swallowing rehabilitation in postoperative oral cancer management [20][21].

The main clinical implication is that early rehabilitation may accelerate the restoration of swallowing function. Resection of oral cancer may disturb the tongue, pharyngeal muscles, and neural structures required for coordinated swallowing and laryngeal closure [22][23]. In the included trials, rehabilitation was usually started after the most acute surgical reactions had partially subsided but before maladaptive compensation and disuse patterns became established. This period may represent an important window for functional training. Improved swallowing may also reduce nasogastric-tube dependence, support nutrition, and help patients tolerate later radiotherapy or chemotherapy [22][24].

The included interventions were mostly multidimensional rather than limited to one exercise. They combined sensory stimulation, including cold-acid stimulation, vibratory input, and air-pulse stimulation; motor training for the lips, tongue, jaw, and laryngeal structures; compensatory techniques such as supraglottic swallowing and the Mendelsohn maneuver; and staged feeding management. This integrated design corresponds to the complex physiology of swallowing, which depends on sensory input, central coordination, and synchronized motor output [25][26]. Sensory stimulation may improve oropharyngeal awareness and swallowing safety [27], while tongue protrusion, tongue pressing, and tongue-clicking exercises target common tongue dysfunction after surgery [28][29]. Feeding guidance then helps transfer training effects to everyday eating.

5 Conclusion

Overall, early rehabilitation appears feasible for patients after oral cancer surgery when the program begins after initial surgical stabilization and is adjusted according to flap condition, pain, wound healing, drainage, and patient tolerance. The pooled findings support its role in perioperative care for improving swallowing recovery and swallowing-related quality of life. Nevertheless, the evidence is constrained by the limited number of randomized trials, partial reporting of randomization procedures, poor allocation concealment, lack of blinding, variability in intervention methods and dosage, and brief follow-up periods. Therefore, the findings should be understood as supportive evidence rather than a final clinical conclusion.

Future studies should use multicenter randomized designs with clear sequence generation, allocation concealment, blinded outcome assessment, and standardized core rehabilitation protocols. Additional research should clarify the optimal timing, frequency, duration, and exercise components tailored to various tumor sites and reconstruction techniques. Preoperative swallowing preparation, digital follow-up, sensorimotor training, tongue-resistance exercises, and long-term home-based adherence support also deserve investigation [22][30]. Longer follow-up periods, such as six months or one year, are needed to assess sustained effects on swallowing function, aspiration-related events, health-economic outcomes, and individualized post-discharge rehabilitation.

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