

Supplementary Data 2. Evidence table and risk of bias

KQ 1. Is early screening effective in improving the prognosis in patients with suspected oropharyngeal dysphagia?

1st author	Design	Participants/intervention	Evaluation tool	Follow-up/duration	Outcomes
Schmidt Leutenberger (2019)	RCT	Adult patients undergoing elective thoracotomy or thoracoscopy (n=438) Intervention (a second clinical assessment of dysphagia): 219 Comparison: 219	Rate of dysphagia Rate of pneumonia median length of hospital stay	Between February 2014 and May 2016	The resulting risk reduction for pneumonia was significant in the experimental group The median length of hospital stay was 6 days in the experimental group and 7 days in the control group
Taveira (2021)	Non-RCT	Patients admitted to an Internal Medicine Unit (n=253) Intervention (the implementation of a screening protocol): 125 Comparison (before the intervention): 128	Presence of dysphagia, vascular risk factors and other comorbidities, respiratory complications, in-hospital length of stay discharge destination)	Before the intervention: 2019.01.01–2019.04.15 After the intervention: 2019.04.16–2019.07.15	After the screening protocol was implemented, respiratory complications were significantly lower, allowing more patients to be discharged home and less mortality
Wangen (2019)	Non-RCT	Acutely ill hospitalized patients Intervention (Massey Bedside Swallow Screening): from 2013 to 2015 Comparison (no screen): from 2016 to 2017	Aspiration-related mortality data	From 2013 to 2015 From 2016 to 2017	After refinement and reimplementation of a nursing-led aspiration risk screening process, mortality data from 2016 to 2017 revealed a decrease to zero aspiration-related events
Posillico (2018)	Non-RCT	Patients with traumatic cervical injuries (n=390) Intervention (bedside dysphagia screen or modified barium swallow): 114 Comparison (no screen): 276	Sensitivity and specificity dysphagia-related complications	Intervention: June 2016–June 2017 Comparison: previous 18-mo cohort	The BDS demonstrated 84.2% sensitivity, 95.8% specificity The prospective study patients demonstrated significantly less dysphagia-related complications (p=0.048) when compared with the retrospective cohort of 276 patients
Schrock (2018)	Non-RCT	Ischemic and hemorrhagic stroke (n=2,372) Intervention (ED dysphagia screen): 419 (ischemic) & 469 (ICH) Comparison (post-screen): 1,022 (ischemic) & 462 (ICH)	ED dysphagia screen (rate of dysphagia) Rates of HAP	Data in a 5-yr period before and after the screen	In the hemorrhagic groups rates of dysphagia were similar but rates of HAP decreased from 19% to 15% in the pre-post groups respectively. In the ischemic stroke groups rates of HAP decreased from 13.8% to 8% in the pre-post groups respectively
Teuschl (2018)	Non-RCT	Admitted with acute stroke (n=1,394) Intervention (screened with GUSS): 993 Comparison (unscreened): 401	SAP rate	Between 2012 and 2014	The screening with GUSS was not a significant marker for the occurrence of SAP Dietary modifications could not prevent SAP in 1 of 7 cases

See (2016)	Non-RCT Postextubation dysphagia in the medical ICU (n=468) Intervention (nurse-performed screening): 187 Comparison (before the intervention): 281	Oral feeding at ICU discharge, re-intubation, ICU readmission, postextubation pneumonia, ICU and/or hospital mortality, ICU and/or hospital length of stay	Before the intervention: October 2012 to January 2014 After the intervention: February 2014 to July 2015	Patients who were screened showed a 111% increase in oral feeding at ICU discharge and a 59% decrease in postextubation pneumonia In the subgroup analysis, NPS was associated with a 127% increase in oral feeding at ICU discharge, an 80% decrease in postextubation pneumonia, and a 25% decrease in hospital length of stay
Sørensen (2013)	Non-RCT Acute stroke patients with moderate to severe dysphagia (n=116) Intervention (early screening, GUSS, and intensified oral hygiene): 58 Comparison 1 (internal control group, same clinic): 58 Comparison 2 (external control group): 30	Incidence of X-ray verified pneumonia	Between March 2009 and January 2010	The incidence of X-ray verified pneumonia was 4 of 58 (7%) in the intervention group compared with 16 of 58 (28%) in the internal control group and with 8 of 30 (27%) in the external control group
Titworth (2013)	Non-RCT Patients with ischemic or hemorrhagic stroke Intervention (nurse-administered bedside dysphagia screen): 648 Comparison (pre-intervention): 1,686	Proportion of patients with pneumonia discharge status percentage of patients with stroke screened	Pre-intervention: 31-mo Post-intervention: 11-mo	Implementation of the MNDS increased dysphagia screening in patients with stroke from 39.3% to 74.2% and was correlated with a decrease in the pneumonia prevalence from 6.5% to 2.8% among patients with stroke
Yeh (2011)	Non-RCT Acute stroke patients admitted to the intensive care unit (n=176) Intervention (3-step swallowing screen): 74 Comparison (no screen): 102	SAP rate Death rate	During admission	Systematic bedside swallowing screening is helpful for prevention of SAP in acute stroke patients admitted to the ICU
Hinchey (2005)	Non-RCT Fifteen acute care institutions, acute ischemic stroke (n=2,532) Intervention & comparison: NA	Screen for dysphagia 여부 type of screen, and in-hospital pneumonia	December 2001 and January 2003	Adherence to a dysphagia screen was 61% The pneumonia rate at sites with a formal dysphagia screen was 2.4% vs. 5.4% at sites with no formal screen

RCT, randomized controlled trial; BDS, Burke dysphagia screening; ED, emergency department; ICU, intensive care unit; HAP, hospital acquired pneumonia; GUSS, Gugging Swallowing Screen; SAP, stroke-associated pneumonia; ICU, intensive care unit; MNDS, Modified Nursing Dysphagia Screen; NA, not available.

	Participant comparability	Selection of participants	Confounding variables	Measurement of exposure	Blinding of outcome assessments	Outcome evaluation	Incomplete outcome data	Selective reporting
Hinchey 2005	+	+	+	+	?	+	+	+
Posillico 2018	+	+	-	?	?	+	+	+
Schrock 2018	+	+	+	+	?	+	+	+
See 2016	+	+	+	?	?	+	+	+
Sorensen 2013	+	+	?	?	?	+	+	+
Taveira 2020	+	+	-	+	?	?	+	+
Teuschi 2018	+	+	-	?	?	+	+	+
Titsworth 2013	+	+	+	+	?	+	+	+
Wangen 2019	?	+	-	+	?	-	?	?
Yeh 2011	+	+	-	+	?	+	+	+

Schmidt 2019	+	+	+	+	+	+	+	?
Random sequence generation (selection bias)	+							
Allocation concealment (selection bias)	+							
Blinding of participants and personnel (performance bias)	-							
Blinding of outcome assessment (detection bias)	+							
Incomplete outcome data (attrition bias)	+							
Selective reporting (reporting bias)	+							
Other bias	?							

Grade of recommendation

	YES	NO
Balance benefits and harms	0	
Confidence in the estimates	0	
Values and preference	0	
Resource use	0	
Recommendation	yes	
Grade	Strong	

KQ 2. Is the standardized screening test more effective for the diagnosis of dysphagia than a single screening test?

Ist author	Design	Participants/intervention	Evaluation tool	Follow-up/duration	Outcomes
Lopes (2019)	Non-RCT	Acute ischaemic stroke (n=344) Intervention (GUSS period): 140 Comparison (water test, pre-GUSS period): 204	Occurrence of in-hospital pneumonia, in-hospital or 3-mo mortality and 3-mo functional independence	First time period (pre-GUSS): February 2014–July 2015 Second period (GUSS): August 2015–October 2016 Initial, 3 mo	There was no difference in the occurrence of stroke-associated pneumonia between the two groups and no differences were found concerning in-hospital mortality, 3-mo functional independence or 3-mo mortality
Shin (2009)	Non-RCT	37 Stroke patients 3 mo later onset Intervention (GUSS) & comparison (3 oz water test, Burke dysphagia screening test, Standardized Swallowing Assessment): all patients	VFSS-FDS, PAS	None	The screening ability of GUSS was equal to other screening tests for dysphagia of stroke patients

RCT, randomized controlled trial; GUSS, Gugging Swallowing Screen; VFSS, videofluoroscopic swallowing study; FDS, functional dysphagia scale; PAS, penetration–aspiration scale.

Lopes 2018	Participant comparability	+	+	+	+	+	+	+	+	+	+	+
Shin 2009	Participant comparability	+	+	+	+	+	+	+	+	+	+	+
	Selection of participants	+	+	+	+	+	+	+	+	+	+	+
	Confounding variables	+	+	+	+	+	+	+	+	+	+	+
	Measurement of exposure	+	+	+	+	+	+	+	+	+	+	+
	Blinding of outcome assessments	+	+	+	+	+	+	+	+	+	+	+
	Outcome evaluation	+	+	+	+	+	+	+	+	+	+	+
	Incomplete outcome data	+	+	+	+	+	+	+	+	+	+	+
	Selective reporting	+	+	+	+	+	+	+	+	+	+	+

Grade of recommendation

	YES	NO
Balance benefits and harms		NO
Confidence in the estimates		O
Values and preference	O	
Resource use		O
Recommendation		Expert consensus

KQ 3. Is VFSS more effective than clinical evaluation in diagnosing oropharyngeal dysphagia?

Ist author	Design	Participants/intervention	Evaluation tool	Follow-up/ duration	Outcomes
Doggett (2001)	SR NA	NA	Pneumonia rate	NA	While bedside exams, VFSS, or FEES appeared effective, the small sizes of available studies did not allow determination of the relative efficacy
Perry & Love (2001)	SR	26 Articles	Lower respiratory tract infection hospital stay mortality	NA	Interpretation of aspiration on videofluoroscopy is not as straightforward but probably also confers additional risk
Leigh (2016)	Non-RCT	Stroke (n=252) Intervention (VFSS after BSST) & comparison (bedside swallowing screening test): 186	Need for changing the diet modification plan	May 2009 to May 2010	Diet recommendation was changed in 95 of the 186 patients (51%) after VFSS Diet was changed to the more conservative level after VFSS in 28% of patients
Rangarathnam (2016)	Non-RCT	Acute stroke (n=60) Intervention (VFSS) & comparison (clinical swallowing exam): all participants	Swallowing physiology	VFSS within 24 h after CSE	CSE may not provide significant physiological information other than hyolaryngeal excursion
Shem (2012)	Non-RCT	Acute cervical spinal cord injury (n=39) Intervention (VFSS) & comparison (BSE): all participants	Sensitivity, specificity, positive and negative predictive values	None	Sensitivity of BSE was 100%, specificity was 93.3% A positive predictive value of BSE was 91.7%, and the negative predictive value was 100%
Wilson (2012)	Non-RCT	Typical hospitalized stroke survivor Intervention (VFSS) & comparison (clinical bedside swallowing evaluation) Decision-analysis model with use of information derived from published studies	Direct medical cost of pneumonia quality-adjusted life-years	None	A videofluoroscopic swallowing study is cost-effective and often saves costs compared with a clinical bedside swallowing evaluation alone or a combined approach

VFSS, videofluoroscopic swallowing study; SR, systematic review; NA, not available; FEES, fiberoptic endoscopic examination of swallowing; RCT, randomized controlled trial; BSST, Bedside Swallowing Screening Test; CSE, clinical swallowing examination; BSE, bedside swallow evaluation.

	Participant comparability	Selection of participants	Confounding variables	Measurement of exposure	Blinding of outcome assessments	Outcome evaluation	Incomplete outcome data	Selective reporting
Leigh 2016	+	+	+	+	?	?	+	+
Rangarathnam 2016	+	+	+	-	+	?	+	+
Stern 2012	+	+	+	+	-	+	+	+
Wilson 2012	+	+	+	+	+	+	+	+

Grade of recommendation

	YES	NO
Balance benefits and harms	0	
Confidence in the estimates	0	
Values and preference	0	
Resource use	0	
Recommendation	yes	
Grade	Strong	

KQ 4. Is FEES more effective than VFSS for the diagnosis of dysphagia?

Ist author	Design	Participants/intervention	Evaluation tool	Follow-up/ duration	Outcomes
Giraldo-Cadavid (2016)	SR	6 Articles, 198 subjects	Diagnostic accuracy (sensitivity, specificity)	NA	FEES had a slight advantage over VFSS to detect aspiration, penetration, and residues
Alagiakrishnan (2013)	SR	19 Articles	Aspiration risk	NA	FEES has equal or greater sensitivity in detecting laryngeal penetration and tracheal aspiration when compared with VFSS. If a patient with dementia is found to be at higher risk for aspiration, the VFSS or FEES can be modified to evaluate different consistencies of food
Aviv (2000)	RCT	Outpatients with dysphagia (n=126) Intervention (FEESST): 50 Comparison (MBS): 76	Pneumonia incidence and pneumonia-free interval	None	There was no statistically significant difference in pneumonia outcomes between the FEESST and MBS groups (pneumonia incidence & pneumonia-free interval)
Moon (2017)	Non-RCT RCT	Patients who had been diagnosed with aspiration pneumonia (n=2,074) divided into two groups according to the presence of neurologic deficit	Findings of VFSS; PAS and PRG	Between January 2009 and July 2017	Only 26.7% of subjects without neurologic deficit underwent VFSS. There were no significant differences in VFSS findings between groups
Fattori (2016)	Non-RCT	Dysphagic patients (n=60) All patients were submitted to FEES (intervention), VFS (comparison) and OPES	VFSS as reference parameters: presence of premature spillage, presence and amount of post-swallowing residue in the hypopharyngeal area, presence of tracheo-bronchial aspiration	None	FEES showed good sensitivity with both semi-solids (85.2%) and liquids (80.4%), and the overall validity of the test was 83.3% and 80%, respectively. VFSS can be considered as the test of choice for assessing pre-swallowing spillage and tracheo-bronchial inhalation, while FEES is the test of choice for studying residue
Hyun (2016)	Non-RCT	Patients with clinically suspected dysphagia (n=35) Intervention (FEES) & comparison (VFSS): all patients	The mPAS and a new scale for pharyngeal residue	None	Chin tuck maneuver is effective in preventing penetration or aspiration and in decreasing pharyngeal residues when evaluated by simultaneous VFSS and FEES. A significant change in the mPAS was caused by chin tuck posture in thin liquid only in the VFSS evaluation
Kim (2013)	Non-RCT	Participants referred for dysphagia assessment (n=69) Intervention (FEES) & comparison (VFSS): all patients	PRSS of each test (VFSS, FEES) and new scale obtained by multiplying scales of both VFSS and FEES	None	It is more appropriate to evaluate the pharyngeal residue by considering of both views obtained by VFSS and FEES simultaneously. In our study, disagreement in ratings of residues between VFSS and FEES was extremely rare as expected

Kelly (2007)	Non-RCT Recruited from dysphagia referrals to speech and language therapy (n=15) Intervention (FEES) & comparison (VFSS): all patients	PAS scored by 15 independent raters	None	Penetration aspiration is perceived to be greater (more severe) from FEES than videofluoroscopy images. Interrater and intrarater reliability ranged from 0.64 to 0.79
Kelly (2006)	Non-RCT Recruited from dysphagia referrals to speech and language therapy (n=15) Intervention (FEES) & comparison (VFSS): all patients	Residue rating scale scored by 15 speech and language therapists	None	Pharyngeal residue was consistently perceived to be greater from FEES than from VFSS. Intra- and inter-rater agreement were similar for both examinations
Wu (1997)	Non-RCT Patients suffering long from dysphagia (n=28) Intervention (FEES) & comparison (VFSS): all patients	Disagreements of five features scored in each examination; premature oral leakage to the pharynx, pharyngeal stasis, laryngeal penetration, tracheal aspiration, effective cough reflex	None	Disagreements in premature oral leakage to the pharynx, pharyngeal stasis, laryngeal penetration, aspiration, effective cough reflex, and velopharyngeal incompetence were 39.3%, 10.7%, 14.3%, 14.3%, 39.3%, and 32.1%, respectively FEES was found to be more sensitive in detecting these risky features of swallowing, except with respect to premature leakage

FEES, fiberoptic endoscopic examination of swallowing; VFSS, videofluoroscopic swallowing study; SR, systematic review; NA, not available; RCT, randomized controlled trial; FEESST, flexible endoscopic evaluation of swallowing with sensory testing; MBS, modified barium swallow test; PAS, penetration-aspiration scale; PRG, Pharyngeal Residue Grade; VFS, videofluoroscopy; OPES, Oro-pharyngo oesophageal scintigraphy; mPAS, modified penetration-aspiration scale; PRSS, pharyngeal residue severity scale.

Aviv 2000	Random sequence generation (selection bias)	+
	Allocation concealment (selection bias)	+
	Blinding of participants and personnel (performance bias)	+
	Blinding of outcome assessment (detection bias)	+
	Incomplete outcome data (attrition bias)	+
	Selective reporting (reporting bias)	+
	Other bias	+

Chih-Hsiu 1997	Participant comparability	+	Selection of participants	+	Confounding variables	+	Measurement of exposure	+	Blinding of outcome assessments	+	Outcome evaluation	+	Incomplete outcome data	+	Selective reporting	+
Fattori 2016	Participant comparability	+	Selection of participants	+	Confounding variables	+	Measurement of exposure	+	Blinding of outcome assessments	+	Outcome evaluation	+	Incomplete outcome data	+	Selective reporting	+
Hyun 2016	Participant comparability	+	Selection of participants	+	Confounding variables	+	Measurement of exposure	-	Blinding of outcome assessments	+	Outcome evaluation	+	Incomplete outcome data	+	Selective reporting	+
Kelly 2006	Participant comparability	+	Selection of participants	+	Confounding variables	-	Measurement of exposure	?	Blinding of outcome assessments	+	Outcome evaluation	+	Incomplete outcome data	+	Selective reporting	+
Kelly 2007	Participant comparability	+	Selection of participants	+	Confounding variables	+	Measurement of exposure	+	Blinding of outcome assessments	+	Outcome evaluation	+	Incomplete outcome data	+	Selective reporting	+
Kim 2013	Participant comparability	+	Selection of participants	+	Confounding variables	?	Measurement of exposure	-	Blinding of outcome assessments	+	Outcome evaluation	+	Incomplete outcome data	+	Selective reporting	+
Moon 2018	Participant comparability	+	Selection of participants	+	Confounding variables	+	Measurement of exposure	-	Blinding of outcome assessments	+	Outcome evaluation	+	Incomplete outcome data	+	Selective reporting	+

Grade of recommendation

	YES	NO
Balance benefits and harms		O
Confidence in the estimates		O
Values and preference		O
Resource use		O
Recommendation		Inconclusive

KQ 5. Is oropharyngeal sensory stimulation therapy effective in improving swallowing function and quality of life?

Ist author	Design	Participants/intervention	Evaluation tool	Follow-up/ duration	Outcomes
Maeda (2017)	RCT	Patients prescribed dysphagia rehabilitation for >3 wk (n=43) Intervention (sensory stimulation): 22 Comparison (sham stimulation): 23	Cough latency times against a 1% citric acid mist, FOIS scores	2 and 3 wk after entry	Changes in cough latency time at 2 wk and oral nutrition intake at 3 wk improved more in the SS group than in the sham group Changes in cough frequency and FOIS scores indicated better outcomes in the SS group
Zhang (2016)	RCT	Patients with dysphagia with medullary infarction (n=82) Intervention 1 (sensory approach combined with traditional swallowing therapy): 28 Intervention 2 (motor approach combined with traditional swallowing therapy): 27 Comparison (traditional swallowing therapy): 27	The water swallow test, Standardized Swallowing Assessment, FOIS, SWAL-QOL scale, mini-mental state examination	4 wk	NMES that targets either sensory input or motor muscle coupled with traditional therapy is conducive to recovery from dysphagia and improves quality of life for patients with dysphagia with medullary infarction. A sensory approach appears to be better than a motor approach
Rofes (2013)	RCT	Chronic poststroke patients with OD (n=20) Intervention (sensory electrical stimulation): 10 Comparison (motor electrical stimulation): 10	Swallowing questionnaires (EAT-10, the SSQ), videofluoroscopic findings, adverse events	January 2012 to October 2012 After 10 days of treatment	Surface-stim is a safe and effective therapy for chronic OD associated to stroke Surface e-stim improved theswallow response and safety of swallow both at sensoryand motor intensities, and the efficacy of swallow after the motor treatment

RCT, randomized controlled trial; FOIS, functional oral intake scale; SS, Sham stimulation; SWAL-QOL, swallowing-related quality of life; NMES, neuromuscular electrical stimulation; OD, oropharyngeal dysfunction; EAT-10, eating assessment tool; SSQ, Sydney Swallowing Questionnaire.

	Random sequence generation (selection bias)	Allocation concealment (selection bias)	Blinding of participants and personnel (performance bias)	Blinding of outcome assessment (detection bias)	Incomplete outcome data (attrition bias)	Selective reporting (reporting bias)	Other bias
Maeda 2017	+	+	+	+	+	+	?
Rofes 2013	+	-	+	?	+	+	?
Zhang 2016	+	-	-	-	?	?	?

Level of evidence

Study design	No. of studies	Risk of bias	Inconsistency	Indirectness	Imprecision	Publication bias	Level of evidence	Importance
RCT	3	-1	0	0	-1	0	Low	2

Grade of recommendation

Balance benefits and harms	YES	NO
Confidence in the estimates	O	O
Values and preference	O	
Resource use	O	
Recommendation	yes	
Grade	Conditional	

KQ 6.1. Are tongue and pharyngeal muscle strengthening exercises effective in improving swallowing function and quality of life, reducing the incidence of pneumonia, and improving quality of life?

Ist author	Design	Participants/intervention	Evaluation tool	Follow-up/duration	Outcomes
Kang (2018)	RCT	Subacute stroke patients (n=20) Intervention (head lift exercise+conventional tx.): 10 Comparison (conventional tx.): 10	Biofeedback-neck flexion strength, swallowing function score	After the intervention	The head-lift exercise group showed a significant within-group change in terms of the neck strength and swallowing function
Mortensen (2015)	RCT	Head-and-neck cancer patient (n=39) Intervention (exercise): 19 Comparison (usual care): 20	EORTC QoLHead and Neck 35, DAHANCA dysphagia score, weight, mouth opening, MBS	Before and after RT(2,5,11M)	Prophylactic swallowing exercises initiated before treatment had no impact on subjective or objective swallowing outcomes within the first year after primary RT
Lazarus (2014)	RCT	Stage II- IV oral/oropharyngeal cancer patients with radiotherapy (n=23) Intervention (tongue strengthening+traditional ex.): 12 Comparison (traditional ex.): 11	MBS, patient based questionnaire, tongue strength test (IOP1), xerostomia (gauche check)	Before and after intervention	Tongue strengthening would result in improved swallow function compared to traditional therapy
van der Molen (2014)	RCT	Advanced stage SSC carcinoma-oral, larynx or nasopharynx with concomitant chemoradiation (n=55) Intervention (experimental ex.): 27 Comparison (standard ex.): 28	VFSS, PAS, FOIS	Before, during, after CCRT: 10 wk, 1 yr, 2 yr follow-up	In the first year post-treatment many initial tumor- and treatment-related problems diminished significantly, except xerostomia (59 %). The overall functional problems at 1 and 2 yr post-CCRT are limited
McCullough (2013)	RCT	Stroke patients (n=18) Intervention (Mendelsohn ex.) Comparison (no Mendelsohn ex.) prospective crossover	VFSS, Hyoid bone movement, DOSS	Before, 2 wk intervention (1st /2nd wk), 1 mo follow-up	The use of the Mendelsohn maneuver as an exercise to improve swallow physiology
Carnaby-Mann (2012)	RCT	Head-and-neck cancer patient (n=58) Intervention (pharyngocise): 20 Comparison 1 (sham): 18 Comparison 2 (usual care): 20	MASA, FOIS, VFSS, mouth opening, nutrition, swallowing m composition (MRI)	6 mo after	Patients completing a program of swallowing exercises during cancer treatment demonstrated superior muscle maintenance and functional swallowing ability
Kotz (2012)	RCT	Head and neck cancer patients receiving CRT (n=26) Intervention (prophylactic swallowing ex.): 4/13 Comparison (usual care): 13	FOIS	Before and after 3/6 mo	Patients who performed prophylactic swallowing exercises designed to address the specific swallowing dysfunctions associated with CRT had significantly better swallowing outcomes than patients who did not receive this intervention at 3 and 6 mo after cancer treatment

McCullough (2012)	RCT	Subacute stroke patient (n=18) Intervention (Mendelsohn ex.) Comparison (no Mendelsohn ex.) Crossover design to compare 2 wk of treatment with 2 wk of no treatment	VFSS, hyoid bone movement, DOSS	Before and after; AABB block	Mendelsohn maneuver, used as a rehabilitation exercise, can improve the duration of hyoid maximum anterior and superior movement and impact the duration of UES opening Rehabilitation training can improve swallow function and slow down the progress of trismus in NPC patients following radiotherapy
Tang (2011)	RCT	Nasopharyngeal cancer with Radiotherapy (n=43) Intervention (Tongue ex., Pharynx, larynx swallowing ex. by guide therapist+TM, ROM ex.): 22 Comparison (no exercise): 21	Wirksamkeit der Trainingsmaßnahmen auf die Dysphagie	Before/after intervention	Rehabilitation training can improve swallow function and slow down the progress of trismus in NPC patients following radiotherapy
van der Molen (2011)	RCT	Head-and-neck cancer patient (n=55) Intervention (experimental ex.): 27 Comparison (standard ex.): 28	PAS, mouth opening, BMI, FOIS, questionnaire of quality of life, VAS	Before 2 wk - CCRT - after 10 wk follow-up	Pretreatment exercises are not efficacious in preventing swallowing problems and trismus, but they seem to reduce the extent and severity of the functional problems after CCRT
Logemann (2009)	RCT	Prolonged oropharyngeal dysphagia and aspiration of at least 3-mo duration (n=19) Intervention (Shaker exercise): 8 Comparison (traditional therapy): 11	VFSS	Before - 6 wk tx. - after	Shaker exercise is effective for other swallowing disorders Shaker patients exhibited a reduction in postswallow aspiration
Mepani (2009)	RCT	Stroke or head and neck cancer patient (n=19) Intervention (Shaker exercise): 8 Comparison (traditional therapy): 11	VFSS	Before - 6 wk tx - after	We have demonstrated an effect of the Shaker Exercise on increasing deglutitive thyrohyoid shortening compared to that seen with traditional dysphagia therapy and maneuvers

RCT, randomized controlled trial; tx., treatment; EORTC QoL, European Organization for Research and Treatment of Cancer Quality-of-Life; DAHANCA, Danish Head and Neck Cancer; MBS, modified barium swallow test; RT, radiotherapy; ex., exercise; IOPI, Iowa Oral Performance Instrument; VFSS, videofluoroscopic swallowing study; PAS, penetration-aspiration scale; FOIS, Functional Oral Intake Scale; CCRT, concurrent chemoradiation therapy; DOSS, Dysphagia Outcome and Severity Scale; MASA, Mann Assessment of Swallowing Ability; MRI, magnetic resonance imaging; CRT, chemoradiation therapy; UES, upper esophageal sphincter; ROM, range of motion; NPC, nasopharyngeal carcinoma; BMI, body mass index; VAS, visual analogue scale.

	Random sequence generation (selection bias)	Allocation concealment (selection bias)	Blinding of participants and personnel (performance bias)	Blinding of outcome assessment (detection bias)	Incomplete outcome data (attrition bias)	Selective reporting (reporting bias)	Other bias
Camaby-Mann 2012	+	+	?	+	+	+	+
Kang 2018	?	?	?	+	+	+	+
Kotz 2012	?	?	?	+	+	+	+
Lazarus 2014	?	?	?	+	+	+	?
Logemann 2009	?	?	?	+	+	+	+
McCullough 2012	+	?	?	+	+	+	+
McCullough 2013	+	?	?	+	+	+	+
Mepani 2009	?	?	?	+	+	+	+
Mortensen 2015	?	?	?	+	+	+	+
Tang 2011	?	?	?	+	+	+	+
van der Molen 2011	?	?	?	+	+	+	+
van der Molen 2014	?	?	?	+	+	+	+

Grade of recommendation

	YES	NO
Balance benefits and harms	0	
Confidence in the estimates	0	
Values and preference	0	
Resource use	0	
Recommendation	yes	
Grade	Strong	

KQ 6.2. Is expiratory muscle strengthening exercise effective in improving swallowing function or quality of life?

Ist author	Design	Participants/intervention	Evaluation tool	Follow-up/duration	Outcomes
Eom (2017)	RCT	Stroke patient (n=26) Intervention (expiratory muscle strength training device tx.): 13 Comparison (sham mode tx.): 13	VDS, PAS	Before and after, 4 wk	The results of this study suggest that EMST can improve the effects of dysphagia after stroke in elderly patients based on swallowing function
Moon (2017)	RCT	Stroke patient (n=18) Intervention (expiratory muscle strength tr.+conventional swallowing): 9 Comparison (conventional swallowing): 9	PAS, FDS, vallecular, piriformis residue	Baseline, intervention 4 wk after	Expiratory muscle strength training is an effective intervention for impaired swallowing function in acute stroke patients with dysphagia
Silverman (2017)	RCT	Multiple sclerosis patients (n=36) Intervention (expiratory muscle strength training tx.): 16 Comparison (sham): 20	Maximal expiratory pressure, PAS, SWAL-QOL	Baseline, intervention 5 wk after	High resistance of the EMST was required in order to improve the functional safety (reduced penetration/aspiration according to PAS), as well as coordination of the complex function of coordinated swallowing, specifically pharyngeal function and saliva management (according to SWAL-QOL subscales)
Park (2016)	RCT	Stroke patient (n=33) Intervention (expiratory muscle strength training device tx.): 17 Comparison (sham mode tx.): 16	PAS, FOIS, sEMG (suprahoid m activation)	Before and after, 4 wk	EMST was effective at stimulating activity in the suprahoid muscle group of patients with dysphagia following a stroke. Moreover, it also aided in the reduction of penetration-aspiration in the pharyngeal phase

Tx., treatment; VDS, videofluoroscopic dysphagia scale; PAS, penetration-aspiration scale; EMST, expiratory muscle strengthening exercise; FDS, functional dysphagia scale; SWAL-QOL, swallowing-related quality of life; FOIS, functional oral intake scale; sEMG, surface electromyography.

	Random sequence generation (selection bias)	Allocation concealment (selection bias)	Blinding of participants and personnel (performance bias)	Blinding of outcome assessment (detection bias)	Incomplete outcome data (attrition bias)	Selective reporting (reporting bias)	Other bias
Eom 2017	?	?	?	+	+	+	+
Moon 2017	?	?	?	?	+	+	+
Park 2016	+	?	?	+	+	+	+
Silverman 2017	?	?	?	+	-	+	-

Grade of recommendation

	YES	NO
Balance benefits and harms	O	O
Confidence in the estimates	O	O
Values and preference	yes	Conditional
Resource use	yes	Conditional
Recommendation	yes	Conditional
Grade	Conditional	Conditional

Q7. Are compensatory swallowing maneuvers effective in improving swallowing function, lowering the incidence of pneumonia, and improving quality of life?

Ist author	Design	Participants/intervention	Evaluation tool	Follow-up/duration	Outcomes
Ko (2021)	Non-RCT	Patients with penetration (n=76) Intervention (ineffective chin-tuck): 50 Comparison (effective chin-tuck): 26	VFSS analysis	None	Penetration ratio was significantly decreased in the chin tuck posture compared with the ratio in the neutral position Significant reducing effect was observed in 26 (34.2%) out of 76 patients residues in the vallecular and pyriformis sinuses were less severe in the effective group
Miyamoto (2021)	Non-RCT	64 Patients who presenting specifically penetration or aspiration All subjects underwent VFSS evaluations during neutral (comparison) and chin-down maneuver (intervention)	VFSS analysis MBSImp PDAI	None	Chin-down maneuver was significantly better than the neutral position in improving the PDAI, tongue base retraction, pharyngeal constriction, anterior hyoid movement, laryngeal elevation, laryngeal closure, UES opening, initiation of pharyngeal swallow, pharyngeal clearance
Lee (2020)	Non-RCT	20 Healthy subjects & 64 dysphagic patients Participants swallowed 5 mL of thin and honey-like liquids in neutral (comparison) and chin-down (intervention) positions	HRM	None	Chin-down maneuver significantly increased tongue base pressure. Chin-down maneuver increased tongue base pressure and decreased UES nadir duration, which the latter was severely limited in dysphagic patients
Lee (2018)	Non-RCT	Hemiplegic stroke patients with dysphagia (n=20) All participants underwent a VFSS, and their heads were randomly turned to a neutral position (comparison), toward the weaker side, toward the stronger side, or to a chin tuck posture (intervention)	VFSS analysis	None	There is significant improvement in the VDS for heads in the chin tuck position compared with heads in the neutral position
Hyun (2016)	Non-RCT	Patients with dysphagia (n=35) All participants underwent VFSS and FEES simultaneously with each neutral (comparison) and chin tuck posture (intervention)	VFSS & FEES analysis	None	Significant change in the mPAS was caused by chin tuck posture in thin liquid. Vallecular residues were decreased by chin tuck posture in rice porridge, and thin liquid. Pyriform sinus residues were decreased by chin tuck posture in rice porridge, curd-type yogurt, and thin liquid
Nagy (2016)	Non-RCT	Participants with vallecular residue (n=26) Intervention (head-turn-plus-chin-down swallow) & comparison (no maneuver): all participants	VFSS analysis	None	Significant reductions in residue for thin and nectar-thick fluids, suggesting that this maneuver can be effective in reducing persistent vallecular residue with these consistencies
Ra (2014)	Non-RCT	Dysphagic patient (n=96) Intervention (effect with chin tuck): 19 Comparison (no effect with chin tuck): 78	VFSS analysis 8-Point penetration-aspiration scale	None	The effectiveness of chin tuck was less than anticipated. Patients without residue in pyriform sinus were more likely to benefit from chin tuck. Sufficient neck flexion was important in chin tuck to prevent aspiration

Park (2013)	Non-RCT	Patients with dysphagia (n=34) Videofluoroscopic swallowing study was performed for each patient in 90° upright (comparison) and in 45° reclining (intervention) sitting posture	VFSS analysis	None	We believe that the 45° reclining sitting posture on swallowing is beneficial for the patients with penetration or aspiration on small amounts of thin liquid and large amounts of residue in valleculae
Solazzo (2012)	Non-RCT	Dysphagia patients (n=321) The patients with aspiration or no transit were tested with VFM to determine whether compensatory postures (intervention) could correct their swallowing disorder	VFM	None	Compensatory postures guaranteed a safe transit in 66/75 (88%) patients with aspiration or no transit. A chin-down posture achieved a safe swallow in 42/75 (56%) patients, a head-turned posture in 19/75 (25.3%) and a hyperextended head posture in 5/75 (6.7%)
Bülw (2002)	Non-RCT	Patients with pharyngeal dysfunction (n=8) Intervention (supraglottic swallow, effortful swallow, chin tuck) & comparison (control): all patients	Simultaneous videoradiography Videomanometry	None	Supraglottic swallow, effortful swallow, chin tuck did not alter peak amplitude or duration of the intrabolus pressure
Ertekin (2001)	Non-RCT	Patients with neurogenic dysphagia (n=51) & healthy controls (n=24) All subjects were instructed to swallow under 5 conditions (neutral, chin up, chin tucked, head rotated right & left)	Piezoelectric sensor and electromyography of the submental muscle complex	None	Dysphagia limit improved significantly in 67% of the patients with unilateral lower cranial lesions when the head was rotated toward the paretic side In dysphagic patients with bilateral symptoms, a significant improvement in dysphagia limit occurred in 50% of patients in chin-tuck position, but in the chin-up position, 55% of the patients experienced a significant decrease in dysphagia limit
Logemann (1997)	Non-RCT	Patients dysphagia after radiation to the head and neck (n=9) Each patient completed two swallows without a voluntary swallow maneuver (comparison) and with the super-supraglottic swallow (intervention)	VFSS analysis	None	Super-supraglottic swallow resulted in changes in airway entrance closure and hyolaryngeal movement. The super-supraglottic swallow results in improved biomechanics of swallow in irradiated head and neck cancer patients
Logemann (1994)	Non-RCT	Head and neck surgical patients with oropharyngeal dysphagia (n=32)	VFSS analysis	None	Postural techniques were successful in eliminating aspiration on at least one volume of liquid in 81% of these patients
Shanahan (1993)	Non-RCT	Neurologically impaired patients who aspirated before the swallow (n=30) Intervention (chin down): 15 Comparison (chin neutral): 15	VFSS analysis	None	Effects of the chin tuck (down) posture are clearly not uniform in their effects on pharyngeal dimensions or on swallow physiology in dysphagic subjects

VFSS, videofluoroscopic swallowing study; MBSImP, modified barium swallow impairment profile; PDAL, presence and degree of airway invasion; UES, upper esophageal sphincter; HRM, high-resolution manometry; VDS, videofluoroscopic dysphagia scale; FEES, fiberoptic endoscopic examination of swallowing; mPAS, modified penetration-aspiration scale; VFM, videofluoromanometry.

	Participant comparability	Selection of participants	Confounding variables	Measurement of exposure	Blinding of outcome assessments	Outcome evaluation	Incomplete outcome data	Selective reporting
Bülow 2002	+	+	+	+	+	+	+	+
Ertekin 2001	-	-	-	-	-	+	+	-
Hyun 2016	+	?	+	+	+	+	+	-
Ko 2021	?	-	-	-	-	+	+	+
Lee 2018	+	-	?	-	?	+	+	+
Lee 2020	-	-	-	+	-	+	+	+
Logemann 1994	-	-	+	+	?	+	+	-
Logemann 1997	+	?	+	+	-	+	+	+
Miyamoto 2021	+	-	+	+	+	+	+	-
Nagy 2016	?	-	?	-	-	+	+	+
Park 2013	?	?	+	+	+	+	+	+
Ra 2014	-	-	-	-	?	+	+	+
Shanahan 1993	?	+	-	-	-	+	+	-
Solazzo 2012	-	-	+	+	-	+	+	-

Grade of recommendation

	YES	NO
Balance benefits and harms	O	O
Confidence in the estimates	O	O
Values and preference	O	O
Resource use	O	O
Recommendation	yes	
Grade	Conditional	

Q8.1. Is surface NMES combined with swallowing therapy better for improving dysphagia in patients with non-progressive neurological disease compared with swallowing therapy alone?

1st author	Design	Participants/intervention	Evaluation tool	Follow-up/duration	Outcomes
Carnaby (2020)	RCT	Stroke patients (n=51) Intervention (McNeill Dysphagia Therapy Program+NMES): 15 Comparison (McNeill Dysphagia Therapy Program+sham NMES or usual care): 15	Clinical swallowing ability (MASA score) Oral intake level (FOIS) Modified Barium Swallow outcomes Patient self-perception Body weight Time to recover pre-stroke diet Dysphagia-related health complications	Post-treatment 3 mo after treatment	Greater benefit (e.g., reduction in dysphagia severity, improved oral intake and earlier return to pre-stroke diet) resulted from a programme of MDTTP alone vs NMES or UC
Jung (2018)	RCT	Stroke patients with dysphagia (n=17) Intervention (NMES combined with saliva or dry swallowing): 9 Comparison (only voluntary swallowing): 8	MBS (VDS and PAS)	Post-treatment	After the intervention, the experimental group showed greater improvement in the pharyngeal phase of the VDS and PAS scores than the control group
Konecny (2018)	RCT	Early stage stroke patients with dysphagia (n=108) Intervention (electrical stimulation of suprahyoid muscles): 54 Comparison (standard orofacial rehabilitation): 54	MBS (OTT, PTT)	Post-treatment 4 wk	Electrical stimulation of suprahyoid muscles significantly reduced the duration of the oral and pharyngeal phases
Sproson (2018)	RCT	Post-stroke dysphagia (n=26) Intervention (NMES with swallowing strengthenig ex.): 13 Comparison (usual speech and language therapy dysphagia care): 13	FOIS PAS SWAL-QOL	Post-treatment Post-treatment 1 mo	A greater proportion of the intervention group made progress in recovery of swallow function compared with the usual-care group
Guillén-Solà (2017)	RCT	Subacute dysphagic stroke patients (n=62) Intervention (SST+sham inspiratory/expiratory muscle training, IEMT+NMES): 21 Comparison 1 (SST): 21 Comparison 2 (SST+IEMT): 21	Respiratory muscle strength Dysphagia severity (PAS) Respiratory complications Volume Viscosity Swallow Test, FOIS, Dysphagia Outcome and Severity Scale	3 wk after treatment 3 mo after treatment	Both IEMT and NMES were associated with improvement in pharyngeal swallowing security signs at the end of the intervention, but the effect did not persist at 3-mo follow-up and no differences in respiratory complications were detected between treatment groups and controls
Zhang (2016)	RCT	Patients with dysphagia with medullary infarction (n=82) Intervention 1 (sensory approach combined with traditional swallowing therapy): 28 Intervention 2 (motor approach combined with traditional swallowing therapy): 27 Comparison (traditional swallowing therapy): 27	Water swallow test SSA FOIS SWAL-QOL MMSE	Post-treatment	NMES that targets either sensory input or motor muscle coupled with traditional therapy is conducive to recovery from dysphagia and improves quality of life for patients with dysphagia with medullary infarction. A sensory approach appears to be better than a motor approach

Terré (2015)	RCT	Neurological oropharyngeal dysphagia (n=20) Intervention (NMES+conventional swallowing therapy): 10 Comparison (sham electrical stimulation+conventional swallowing therapy): 10	FOIS Videofluoroscopic examination (OTT, PTT, PDT) Esophageal manometry	Post-treatment 3 mo after treatment	NMES shortens the recovery time and significantly improves swallowing function in patients with acute oropharyngeal dysphagia secondary to acquired brain injury
Lee (2014)	RCT	Dysphagic stroke patients (n=57) Intervention (NMES combined with TDT): 31 Comparison (TDT only): 26	FOIS	3, 6, 12 wk after baseline	Both groups showed a significant improvement on the FOIS after treatment. The FOIS score was significantly more improved at 3 and 6 wk after baseline in the NMES/TDT group than in the TDT group
Xia (2011)	RCT	Patients with post-stroke dysphagia (n=120) Intervention 1 (NMES): 40 Intervention 2 (NMES+conventional swallowing therapy): 40 Comparison (conventional swallowing therapy): 40	SSA VFSS SWAL-QOL sEMG	Prior to and after treatment	VitalStim therapy coupled with conventional swallowing training was conducive to recovery of post-stroke dysphagia
Lim (2009)	RCT	Patients with dysphagia caused by stroke (n=28) Intervention (NMES+thermal tactile stimulation): 16 Comparison (thermal tactile stimulation only): 12	Swallowing functional score PAS PTT	4 wk after treatment	The experimental group showed more significant improvement in the swallow function scoring system, penetration-aspiration scale and pharyngeal transit time than the control group
Toyama (2014)	non RCT	Dysphagia after brain injury (n=26) Intervention (NMES+conventional tx.): 12 Comparison (conventional tx.): 14	MBS (VDS, FOIS, displacement of anterior and superior hyoid bone and larynx)	8 wk after treatment	NMES combined with conventional treatment is superior to conventional treatment alone in patients with dysphagia following treatment for brain injury
Kushner (2013)	non RCT	Acute stroke feeding tube-dependent dysphagia (n=92) Intervention (NMES+traditional dysphagia therapy/progressive resistance training): 65 Comparison (Traditional dysphagia therapy/progressive resistance training): 27	FOIS	After treatment	Significant improvement in swallowing performance was found for the NMES group compared with the TDT/PRT group

NMES, neuromuscular electrical stimulation; RCT, randomized controlled trial; MASA, Mann Assessment of Swallowing Ability; FOIS, functional oral intake scale; MDTP; McNeill Dysphagia Therapy; UC, usual care; MBS, modified barium swallow test; VDS, videofluoroscopic dysphagia scale; PAS, penetration-aspiration scale; OTT, oral transit time; PTT, pharyngeal transit time; SWAL-QOL, swallowing-related quality of life; SST, standard swallow therapy; IEMT, inspiratory/expiratory muscle training; SSA, Standardized Swallowing Assessment; MMSE, mini-mental state examination; PDT, pharyngeal delay time; TDT, traditional dysphagia therapy; VFSS, videofluoroscopic swallowing study; sEMG, surface electromyography; tx., treatment.

	Participant comparability	Selection of participants	Confounding variables	Measurement of exposure	Blinding of outcome assessments	Outcome evaluation	Incomplete outcome data	Selective reporting
Kushner 2013	+	+	+	+	?	+	+	+
Toyama 2014	?	+	+	+	+	+	+	+

	Random sequence generation (selection bias)	Allocation concealment (selection bias)	Blinding of participants and personnel (performance bias)	Blinding of outcome assessment (detection bias)	Incomplete outcome data (attrition bias)	Selective reporting (reporting bias)	Other bias
Carnaby 2020	+	+	+	+	+	+	+
Guillén-Soià 2017	+	+	-	+	+	+	+
Jung 2018	?	?	?	?	+	+	+
Konecny 2018	?	?	?	?	+	+	+
Lee 2014	+	+	-	+	+	+	?
Lirm 2009	-	-	-	-	+	+	?
Sproson 2018	+	+	-	-	+	+	?
Terré 2015	+	+	+	+	+	+	+
Xia 2011	-	-	-	-	+	+	?
Zhang 2016	?	?	?	+	+	+	+

Grade of recommendation

	YES	NO
Balance benefits and harms	0	
Confidence in the estimates	0	
Values and preference	0	
Resource use	0	
Recommendation	yes	
Grade	Strong	

KQ 8.2. Is surface NMES combined with swallowing therapy better for improving dysphagia compared with swallowing therapy alone in patients with head and neck cancer?

Ist author	Design	Participants/intervention	Evaluation tool	Follow-up/duration	Outcomes
Ryu (2009)	RCT	Patients suffering dysphagia following treatment for head and neck cancer (n=26) Intervention (NMES): 14 Comparison (sham stimulation): 12	Functional dysphagia scale Clinical dysphagia scale American speech-language-hearing association national outcome measurement system swallowing level scale MDADI	Post-treatment	NMES combined with traditional swallowing training is superior to traditional swallowing training alone in patients suffering from dysphagia following treatment for head and neck cancer
Bhatt (2015)	Non-RCT	Patients with head and neck cancer treated with definitive chemoradiation (n=95) Intervention (Transcutaneous NMES+swallowing rehabilitation): 41 Comparison (swallowing rehabilitation): 54	MBS (PAS) FOIS/ swallowing performance status scale	Post-treatment	A benefit in reducing dysphagia with TNMES in patients with locally advanced head and neck cancer Significant benefits were only demonstrated using the FOIS assessment
Lin (2011)	Non-RCT	Nasopharyngeal carcinoma subjects with dysphagia (n=20) Intervention (FES): 10 Comparison (home rehabilitation): 10	PAS, OTT, PTT, and pharyngeal delay time MDADI score chinese version Quality of life questionnaire scores, movement of hyoid bone, amount of pyriform sinuses stasis	Post-treatment	The degree of improvement in the movement speed of the hyoid bone in the thin barium and the PAS of the paste barium were statistically significantly greater in the FES group than in the HRP group

NMES, neuromuscular electrical stimulation; RCT, randomized controlled trial; MDADI, MD Anderson dysphagia inventory; MBS, modified barium swallow test; PAS, penetration-aspiration scale; FOIS, functional oral intake scale; TNMES, transcutaneous neuromuscular electrical stimulation; FES, functional electrical stimulation; OTT, oral transit time; PTT, pharyngeal transit time; HRP, home rehabilitation program.

	Bhatt 2015	Lin 2011
Participant comparability	+	+
Selection of participants	+	+
Confounding variables	+	-
Measurement of exposure	+	+
Blinding of outcome assessments	-	+
Outcome evaluation	+	+
Incomplete outcome data	+	+
Selective reporting	+	+

	Ryu 2009
Random sequence generation (selection bias)	+
Allocation concealment (selection bias)	+
Blinding of participants and personnel (performance bias)	+
Blinding of outcome assessment (detection bias)	+
Incomplete outcome data (attrition bias)	+
Selective reporting (reporting bias)	?
Other bias	-

Grade of recommendation

	YES	NO
Balance benefits and harms	O	O
Confidence in the estimates	O	O
Values and preference	O	yes
Resource use	yes	Conditional
Recommendation	yes	Conditional
Grade	Conditional	Conditional

KQ 8.3. Does PES improve swallowing function and prevent pneumonia in patients with dysphagia caused by non-progressive neurological disease?

Ist author	Design	Participants/intervention	Evaluation tool	Follow-up/ duration	Outcomes
Dziewas (2018)	RCT	Patients with recent stroke who required tracheotomy (n=69) Intervention (PES): 35 Comparison (sham stimulation): 34	Adverse event Swallowing (DSRS, FOIS)	Day 2, 30, 90	In patients with stroke and subsequent tracheotomy, PES increased the proportion of patients who were ready for decannulation in this study population, many of whom received PES within 1 mo of their stroke
Bath (2016)	RCT	Subacute stroke patients with dysphagia (n=126) Intervention (PES): 70 Comparison (sham): 56	MBS (PAS) DSRS, mRS, Barthel Index, NIHSS, EQ-5D (QoL), EQ-5D-HUS	Post-treatment 2 wk Post-treatment 12 wk	In patients with subacute stroke and dysphagia, PES was safe but did not improve dysphagia
Vasant (2016)	RCT	Dysphagia poststroke (n=36) Intervention (PES): 18 Comparison (sham): 18	MBS (PAS) FEES DSRS Time to hospital discharge	Post-treatment 2 wk, 3 mo	Although the direction of observed differences were consistent with PES accelerating swallowing recovery over the first 2 wk post-intervention, suboptimal recruitment prevents definitive conclusions
Suntrup (2015)	RCT	Stroke patients with severe dysphagia precluding decannulation (n=30) Intervention (PES): 20 Comparison (sham): 10	Fiberoptic endoscopic evaluation of swallowing (for decannulation) FOIS mRS Length of hospital day on ICU	Post-treatment before discharge	EPS enhanced remission of dysphagia as assessed with FEES, thereby enabling decannulation in 75 % of patients
Jayasekeran (2010)	RCT	Stroke patients with dysphagia (n=28) Intervention (active PES): 16 Comparison (sham PES): 12	Swallowing functional score DSRS	Post-treatment 2 wk	PES is safe and well tolerated in stroke and appears to reduce aspiration, improve global feeding status, and reduce hospital stay

PES, pharyngeal electrical stimulation; RCT, randomized controlled trial; DSRS, Dysphagia Severity Rating Scale; FOIS, functional oral intake scale; MBS, modified barium swallow test; PAS, penetration-aspiration scale; mRS, modified Rankin Scale; NIHSS, National Institutes of Health Stroke Scale; QoL, quality of life; HUS, health-utility score; FEES, fiberoptic endoscopic examination of swallowing; ICU, intensive care unit.

	Random sequence generation (selection bias)	Allocation concealment (selection bias)	Blinding of participants and personnel (performance bias)	Blinding of outcome assessment (detection bias)	Incomplete outcome data (attrition bias)	Selective reporting (reporting bias)	Other bias
Bath 2016	+	+	+	+	+	+	+
Dziewas 2018	?	?	-	+	+	+	?
Jayasakeran 2010	-	-	-	-	+	+	?
Suntrup 2015	+	+	-	-	+	+	+
Vasant 2016	+	+	-	-	+	+	?

Grade of recommendation

	YES	NO
Balance benefits and harms	0	
Confidence in the estimates	0	
Values and preference	0	0
Resource use	0	0
Recommendation		Against

KQ 9. Is stimulating the TRP channel with drugs effective in improving swallowing function, lowering the incidence of pneumonia, and improving the quality of life in patients with OD?

Ist author	Design	Participants/intervention	Evaluation tool	Follow-up/duration	Outcomes
Cabib (2020)	RCT	Patients with unilateral stroke and chronic unsafe swallow (n=12) Intervention (oral capsaicin) & comparison (placebo): all patients, cross-over	PAS Swallowing safety Biomechanical parameters	After intervention	No specific effects on PAS and biomechanical parameters were found with the application of any intervention, either in the global analysis or separately by study group
Cui (2020)	RCT	Patients with dysphagia after stroke (n=92) Intervention (combined capsaicin and ice stimulation): 46 Comparison (ice stimulation): 46	WST SSA	3 wk	The combined use of capsaicin with ice stimulation is beneficial to the recovery of swallowing function of patients with dysphagia
Tomsen (2019)	RCT	Older patients with OD (n= 28) Intervention 1 (oral capsaicin treatment - acute): 7 Intervention 2 (oral capsaicin treatment - subacute): 7 Comparison (placebo): 7 acute tx. & 7 subacute tx.	VFS (PAS, residue, time variables) EEG (latency and amplitude of pharyngeal ERP)	After treatment (immediate and 2 wk)	Acute treatment with low doses of capsaicinoids did not have any effect. In contrast, subacute treatment with the same concentration of capsaicinoids induced significant cortical changes that correlated with significant improvements in the OSR
Wang (2019)	RCT	Stroke patients with dysphagia: 60 Intervention (thermal tactile stimulation with capsaicin+nectar bolus): 30 Comparison (thermal tactile stimulation+bolus with placebo): 30	V-VST EAT-10 SSA WST	3 wk	The decrease in EAT and SSA score of the capsaicin intervention group was significantly greater than that of the placebo control group. Regular use of natural capsaicin could promote the recovery of swallow function in stroke patients with dysphagia
Alvarez-Berdugo (2018)	RCT	Patients with OD (n=142) Intervention 1 (capsaicinoids): 30 Intervention 2 (piperine): 40 Intervention 3 (menthol): 36 Comparison (placebo): 33	VFS (residue, penetration, time variables)	Immediate (T1: 5 min, T2: 15 min)	Natural capsaicinoids have a stronger therapeutic effect on VFS signs and swallow response by stimulating TRPV1 than TRPV1/A1 or TRPM8 agonists. While TRP stimulants increased bolus velocity and reduced swallow response times, thickeners reduced bolus velocity and further delayed the swallow response
Kondo (2017)	RCT	Elderly dysphagic patients (n=20) Intervention (aural stimulation with capsaicin ointment): 10 Comparison (placebo): 10	Endoscopic swallowing score, Sensory-Motor-Reflex-Clearance scale	Immediate (5, 30, 60 min)	The decrease in endoscopic swallowing scores of group C was significantly greater than that of group P at post-30 and -60 min (p<0.05) The increase of the reflex score in group C was significantly higher than that of group P at post-30 and -60 min (p<0.05)
Nakato (2017)	RCT	Older patients with OD (n=49) Intervention (capsaicin) & comparison (placebo): all patients, crossover	EAT-10 SF-8 FSSG VAS GI series	1 wk	Elevated salivary substance P concentrations stimulated by capsaicin improve the safety and efficacy of swallowing, and shorten the swallow response

Ortega (2016)	RCT	Older patients (70 yr or older) with OD (n=38) Intervention (TRPV1 agonist): 19 Comparison (transcutaneous sensory electrical stimulation): 19	VFS (PAS, kinematic variables), EAT-10, V-VST	2 wk	Sensory stimulation with either therapy improved safety of swallow and OSR in older patients with OD, reducing the severity of OD in a significant subgroup of these patients
Ebihara (2006a)	RCT	Poststroke residents (n=105) Intervention (olfactory stimulation with black pepper oil): 35 Comparison 1 (olfactory stimulation with lavender oil): 33 Comparison 2 (distilled water): 35	Latent time of swallowing reflex, number of swallows	Immediate and 30 day	Inhalation of BPO resulting in improvement of the reflexive swallowing movement, might benefit older poststroke patients with dysphagia regardless of their level of consciousness or physical and mental status
Ebihara (2006b)	RCT	Elderly patients with dysphagia (n=14) Intervention (various concentrations of menthol) & Comparison (distilled water): all patients, crossover Comparison (distilled water)	LTSR	Immediate	LTSR was significantly shortened in a concentration-dependent manner. Menthol stimulation as well as cold stimulation restores sensitivity to the triggering of the swallowing reflex
Ebihara (2005)	RCT	Participants in nursing homes (n=64) Intervention (capsaicin troche): 32 Comparison (placebo troche): 32	LTSR	4 wk	Daily capsaicin supplementation resulted in a significant improvement in upper protective respiratory reflexes, particularly in older people with a high risk for aspiration
Nascimento (2021)	Non-RCT	Patients with OD (n=17) Intervention (10 uM capsaicin solution administered orally) & Comparison (pre-post intervention): all patients	SSF	Immediate	After TRPV1 stimulation with capsaicin, PSD patients showed a significant increase in SSF compared to the frequency registered before treatment
Tomsen (2020)	Non-RCT	Patients with OD (n=58) Intervention 1 (Cinnamaldehyde-Zinc group): 21 Intervention 2 (Citral group): 21 Intervention 3 (Citral-Isopulegol group): 16 Comparison (pre-post): all patients	PAS Prevalence of patients with safe swallows LVC time UESO time	TI: 2 min, T2: 7 min	TRPA1 stimulation with CIN-Zn or CIT improves the swallow response which, in the case of CIN-Zn, is associated with a significant improvement in cortical activation and safety of swallow
Kondo (2014)	Non-RCT	Elderly patients with non-obstructive dysphagia (n=26) Intervention (capsaicin ointment): 26 Comparison (Pre-post intervention): all patients	Endoscopic swallowing score	Immediate (5, 30, 60 min and 1 wk)	Stimulation of the external auditory canal with ointment containing capsaicin improves swallowing function in elderly patients with non-obstructive dysphagia
Rofes (2014)	Non-RCT	Patients with clinical signs of OD (n=40) Intervention 1 (piperine 150 µM): 20 Intervention 2 (piperine 1 mM): 20 Comparison (pre-post intervention): all patients	VFS (penetration, residue, PAS, kinematic variables)	None	Piperine reduced the prevalence of penetrations into the laryngeal vestibule at both concentrations, and the severity of the penetrations at the highest concentration
Rofes (2013)	Non-RCT	Older patients with OD (n=66) Intervention (capsaicinoids): 33 Comparison (thicker): 33	VFS (penetration, residue, PAS, kinematic variables)	None	Treatment with capsaicinoids reduced both penetrations and pharyngeal residue and shortened the time of LVC UESO and maximal hyoid and laryngeal displacement

TRP, transient receptor potential; OD, oropharyngeal dysphagia; RCT, randomized controlled trial; PAS, penetration-aspiration scale; WST, water swallow test; SSA, Standardized Swallowing Assessment; tx., treatment; VFS, videofluoroscopic; EEG, electroencephalography; ERP, event-related potential; OSR, oropharyngeal swallow response; V-VST, volume-viscosity swallow test; EAT-10, eating assessment tool; SF-8, 8-item short-form health survey; FSSG, frequency scale for the symptoms of gastroesophageal reflux disease; VAS, visual analogue scale; GI, gastrointestinal; BPO, black pepper oil; LTSR, latent time of swallowing reflex; SSF, spontaneous swallow frequency; PSD, post-stroke depression; LVC, laryngeal vestibule closure; UESO, upper esophageal sphincter opening.

	Participant comparability	Selection of participants	Confounding variables	Measurement of exposure	Blinding of outcome assessments	Outcome evaluation	Incomplete outcome data	Selective reporting
Kondo 2014	+	?	+	+	+	+	+	?
Nascimento 2021	+	?	+	+	+	-	+	+
Rofes 2013	+	?	+	+	+	+	+	+
Rofes 2014	+	?	+	+	+	+	+	+
Tomsen 2020	+	?	+	+	+	+	+	+

	Random sequence generation (selection bias)	Allocation concealment (selection bias)	Blinding of participants and personnel (performance bias)	Blinding of outcome assessment (detection bias)	Incomplete outcome data (attrition bias)	Selective reporting (reporting bias)	Other bias
Alvarez-Berdugo 2018	-	?	?	?	+	+	+
Cabib 2020	+	?	+	+	+	+	+
Cui 2020	+	?	-	+	?	?	+
Ebihara 2005	+	-	+	?	+	?	+
Ebihara 2006a	+	-	+	?	+	?	+
Ebihara 2006b	?	?	+	+	+	?	-
Kondo 2017	+	+	+	+	+	+	+
Nakato 2017	+	+	+	+	+	?	-
Ortega 2016	+	?	+	-	?	+	+
Tomsen 2019	+	?	?	+	+	+	+
Wang 2019	+	?	+	?	?	?	+

Grade of recommendation

	YES	NO
Balance benefits and harms	O	O
Confidence in the estimates	O	O
Values and preference	O	O
Resource use	O	
Recommendation	yes	
Grade	Conditional	

KQ 10. Is biofeedback training effective for improving swallowing function, lowering the incidence of pneumonia, and improving quality of life?

Ist author	Design	Participants/intervention	Evaluation tool	Follow-up/duration	Outcomes
Albuquerque (2019)	SR	6 Articles, 222 subjects	The FOIS, WST, VFSS, range of movement of the hyoid bone (G)-related quality of life (SWAL-QOL), and swallowing time.	NA	A combination of conventional rehabilitation with adjunctive electromyographic biofeedback was more effective in improving dysphagia than exclusive conventional rehabilitation
Benfield (2019)	SR	23 Articles, 448 subjects	FOIS, PAS, feeding tube removal, hyoid displacement	NA	Dysphagia therapy augmented by biofeedback using sEMG and accelerometry enhances hyoid displacement but functional improvements in swallowing are not evident
Shin (2019)	RCT	Post-stroke dysphagia (n=45) Intervention 1 (visuoauditory biofeedback) Intervention 2 (visual biofeedback) Comparison (self-exercise)	% MVIC of suprahyoid muscle	4 wk, 6 wk	Comparing between the post- test and the follow-up test, all three groups showed the reduction of suprahyoid muscle activity with the mean comparing, followed VABG, VBG and SG
Moon (2017)	RCT	Post-stroke dysphagia (n=16) Intervention (additional surface electromyography biofeedback): 8 Comparison (additional swallowing training): 8	FDS, PAS	4 wk	Intervention group improved significantly than control group in dietary level. Swallowing training with surface electromyography biofeedback may be a effective dysphagia therapy to improve on dietary level in acute stroke patients with dysphagia
Park (2019)	Non-RCT	Stroke patients with dysphagia (n=10) Intervention (NMES using EMG biofeedback) & (pre-intervention)	VDS, PAS	After treatment	the use of NMES combined with EMG-biofeedback had the potential to improve oropharyngeal swallowing in stroke patients with dysphagia
Li (2016a)	Non-RCT	Patients with chronic dysphagia (n=21) Intervention (traditional swallowing treatment & VR feedback therapy) & comparison (before treatment)	FOIS	After treatment	After therapy, the FOIS results significantly improved
Li (2016b)	Non-RCT	Post-stroke dysphagia (n=20) Intervention (laryngeal elevation ex w game-based biofeedback): 10 Comparison (laryngeal elevation ex w/o biofeedback): 10	Hyoid bone displacement, FOIS scores, and NG tube removal rate	After therapy	Laryngeal elevation training combined with game-based biofeedback augments the change in hyoid bone displacement and FOIS scores, and increases the nasogastric tube removal rate in patients with poststroke dysphagia
Kang (2013)	Non-RCT	Post-stroke dysphagia (n=6) Intervention (traditional swallowing rehabilitation & EMG biofeedback) & comparison (before treatment): all patients	PAS, GUSS, and FOIS	After treatment	The swallowing function of the acute stroke patients had been improved in PAS, GUSS, and FOIS after EMG biofeedback
Bogaardt (2009)	Non-RCT	Post-stroke dysphagia (n=11) Intervention (surface electromyography as biofeedback) & Comparison (before treatment)	FOIS	After treatment	Surface electromyography as biofeedback in the treatment of chronic dysphagia after stroke is an effective adjunct to standard therapy for post-stroke dysphagia

Crary (2004)	Non-RCT Post-stroke dysphagia (n=25) and head & neck cancer (n=20) Intervention (systematic therapy program with surface electromyographic biofeedback) & comparison (before treatment)	FOIS	After treatment	A systematic therapy program supplemented with surface electromyographic biofeedback improved functional swallowing status in both groups. Patients with dysphagia following stroke demonstrated greater improvement than those in the head/neck cancer group
Huckabee (1999)	Non-RCT Patients with chronic dysphagia subsequent to a single brainstem injury (n=10) Intervention (biofeedback+direct treatment) & comparison (pretreatment): all patients	Dysphagia severity level, functional diet level (author's own scale)	After treatment, 6 mo, 1 yr and pulmonary status	Statically significant improvements were observed in swallowing physiology, diet level, and pulmonary status

SR, systematic review; FOIS, functional oral intake scale; WST, water swallow test; VFSS, videofluoroscopic swallowing study; SWAL-QOL, swallowing-related quality of life; NA, not available; PAS, penetration-aspiration scale; (s)EMG, (surface) electromyography; RCT, randomized controlled trial; MVIC, maximal voluntary isometric contraction; VABG, visioauditory biofeedback group; VBG, visual biofeedback group; SG, self-exercise group; FDS, functional dysphagia scale; NMES, neuromuscular electrical stimulation; VDS, videofluoroscopic dysphagia scale; VR, virtual reality; NG, nasogastric; GUSS, Gugging Swallowing Screen.

Moon 2017	Random sequence generation (selection bias)	Allocation concealment (selection bias)	Blinding of participants and personnel (performance bias)	Blinding of outcome assessment (detection bias)	Incomplete outcome data (attrition bias)	Selective reporting (reporting bias)	Other bias
Shin 2019	+	+	+	+	+	+	?
Bogaardt 2009	+	+	+	+	+	+	?
Crary 2004	+	+	+	+	+	+	?
Huckabee 1999	+	+	+	+	+	+	?
Kang 2013	+	+	+	+	+	+	?
Li 2016a	+	+	+	+	+	+	?
Li 2016b	+	+	+	+	+	+	?
Park 2019	+	+	+	+	+	+	?

Participant comparability	+	+	+	+	+	+	+
Selection of participants	+	+	+	+	+	+	+
Confounding variables	+	+	+	+	+	+	+
Measurement of exposure	?	?	?	?	?	?	?
Blinding of outcome assessments	+	+	+	+	+	+	+
Outcome evaluation	+	+	+	+	+	+	+
Incomplete outcome data	+	+	+	+	+	+	+
Selective reporting	+	+	+	+	+	+	+

Grade of recommendation

	YES	NO
Balance benefits and harms	0	0
Confidence in the estimates	0	0
Values and preference	0	0
Resource use	yes	
Recommendation	yes	
Grade	Conditional	

KQ 11.1. Is CP BTX injection effective for improving swallowing function, reducing the risk of aspiration pneumonia, and improving diet in patients with CP dysfunction?

1st author	Design	Participants/intervention	Evaluation tool	Follow-up/duration	Outcomes
Huai (2020)	Non-RCT	Patients with deglutition disorders (n=17) Intervention (CT-guided percutaneous injection of BTXA) & comparison (NA)	FOIS, deglutition Handicap Index	1 mo	CT-guided percutaneous injection of BTXA is probably a relatively safe, well-tolerated, and viable technique for the treatment of CP dysphagia caused by brainstem injury
Jeong (2018)	Non-RCT	Patients with CP dysfunction (n=14) Intervention (endoscopic BTX injection) & comparison (NA)	FOIS, VFSS, clinical course	1-6 mo	Eleven patients (78.6%) were managed successfully with the injection. An endoscopic BTX injection may be a good treatment option for patients with dysphagia and CP dysfunction due to a neurological disorder
Alfonsi (2017)	Non-RCT	Patients with neurogenic dysphagia associated with incomplete or absent opening of the UES (n=67) Intervention (incobotulinumtoxinA injection) & comparison (NA)	Clinical course, FEES, DOSS	18-46 wk	BTX treatment is highly effective in the treatment of neurogenic dysphagia. An important "caveat" of BTX treatment is that absence of a therapeutic response to the first injection should be considered a risk factor for side possible effects
Kim (2017)	Non-RCT	Patients who showed no or limited ability to oral feed after maximum swallowing rehabilitation (n=36) Intervention (BTX injection) & comparison (NA)	VFSS, FEES, PAS, DRS, NIH swallowing safety scale	18-46 wk	The total success rate was 63.9%. The complication rate was very low, with only 1 patient showing temporary unilateral vocal fold paralysis. BTX injection was more effective in patients with cranial nerve IX or X palsy than in those without it
Kelly (2013)	Non-RCT	Patients with UES dysfunction (n=49) Intervention (BTX injection); 32 Comparison (BTX injection+myotomy); 17	Clinical course, EAT-10	NA	CP BTX injection was effective in the treatment of UES dysfunction. The EAT-10 scores demonstrated a general trend toward improved swallowing outcomes after CP BTX injection

CP, cricopharyngeal; BTX, botulinum toxin; RCT, randomized controlled trial; CT, computed tomography; NA, not available; FOIS, functional oral intake scale; VFSS, videofluoroscopic swallowing study; UES, upper esophageal sphincter; FEES, fiberoptic endoscopic examination of swallowing; DOSS, Dysphagia Outcome and Severity Scale; PAS, penetration-aspiration scale; DRS, disability rating scale; NIH, National Institutes of Health; EAT-10, eating assessment tool.

	Participant comparability	Selection of participants	Contounding variables	Measurement of exposure	Blinding of outcome assessments	Outcome evaluation	Incomplete outcome data	Selective reporting
Alfonso 2017	?	+	+	+	+	+	+	+
Huai 2020	?	+	+	+	+	+	+	+
Jeong 2018	?	+	+	+	+	+	+	+
Kelly 2013	+	+	+	+	+	+	+	+
Kim 2017	?	+	+	+	+	+	+	+

Grade of recommendation

	YES	NO
Balance benefits and harms		0
Confidence in the estimates		0
Values and preference	0	
Resource use	yes	0
Recommendation	Conditional	
Grade		

KQ 11.2. Is CP myotomy effective in improving swallowing function, reducing the risk of aspiration pneumonia, and improving diet in patients with CP dysfunction?

Ist author	Design	Participants/intervention	Evaluation tool	Follow-up/ duration	Outcomes
Ho (2011)	Non-RCT	Patients who underwent CO2 laser-assisted endoscopic CP myotomy (n=7) Intervention (CP myotomy) & comparison (NA)	MDADI, FOSS score, complication, operation time	6 mo after	ECPM is beneficial as a primary treatment for CP dysfunction
Brigand (2007)	Non-RCT	Patients who had CP myotomy (n=253) Intervention (CP myotomy) & comparison (NA)	Symptom, complication and mortality	NA	Pulmonary aspiration and lethal respiratory distress occurred only in patients with myogenic dysphagia. Persistent aspiration can lead to laryngeal exclusion or resection with permanent tracheostomy
Dauer (2006)	Non-RCT	Patients underwent CP myotomy without a concomitant head & cancer (n=22) Intervention (endoscopic vs. open CP myotomy) & comparison (NA)	Hospital stay, operative time, functional outcome	NA	The laser technique is at least as effective as the transcervical approach for CPM to improve dysphagia symptoms in the properly selected patient, with a low risk of major complications
Takes (2005)	Non-RCT	Patients with idiopathic CP dysfunction (n=10) Intervention (endoscopic myotomy of the CP muscle with a CO2 laser) & comparison (NA)	Clinical assessment and history, questionnaire	NA	Endoscopic laser surgery seems to be a safe and effective technique to treat CP dysfunction
McKenna (1992)	Non-RCT	Patients underwent CP myotomy (n=47) Intervention (CP myotomy) & comparison (NA)	Symptom	NA	Eighty percent of patients were markedly improved or given normal swallow by CP myotomy, even though their cine-esophagrams and/or manometries revealed no disease

CP, cricopharyngeal; RCT, randomized controlled trial; NA, not available; MDADI, MD Anderson dysphagia inventory; FOSS, Functional Outcome Swallowing Scale; ECPM, endoscopic CP myotomy; CPM, CP myotomy.

	Participant comparability	Selection of participants	Confounding variables	Measurement of exposure	Blinding of outcome assessments	Outcome evaluation	Incomplete outcome data	Selective reporting
Brigand 2007	+	+	+	-	-	+	+	+
Dauer 2006	-	-	-	-	-	+	+	+
Ho 2011	-	-	-	-	-	+	+	+
Mickenna 1992	-	-	-	-	-	+	+	+
Takes 2005	-	-	-	-	-	+	+	+

Grade of recommendation

	YES	NO
Balance benefits and harms		0
Confidence in the estimates		0
Values and preference		0
Resource use		0
Recommendation		Expert consensus

KQ 11.3. Is balloon dilatation effective in improving swallowing function, reducing the risk of aspiration pneumonia, and improving diet in patients with CP dysfunction?

Ist author	Design	Participants/intervention	Evaluation tool	Follow-up/duration	Outcomes
Wei (2017)	RCT	Brainstem stroke patients with dysphagia (n=30) Intervention (modified balloon dilatation+conventional therapy): 15 Comparison (conventional therapy): 15	MEP, VFSS, NIHSS score, FOIS	Day before the first treatment & day after the last session	Modified balloon dilatation therapy can increase the excitability of affected projection in patients with unilateral brainstem stroke
Arenaz Búa (2015)	RCT	CP dysfunction patient (n=8) Intervention (balloon dilatation): 4 Comparison (laser myotomy): 4	Sydney Swallowing Questionnaire, videomanometry, esophageal sphincter sagittal diameter	1 and 6 mo after treatment	CP dysfunction treatment by either laser myotomy or balloon dilatation improved upper oesophageal sphincter opening during at least 6 mo
Jo (2020)	Non-RCT	Patients with CPD (n=36) & patients propensity matching (n=24) Intervention (EBD): 36 Comparison (RBS): 24	FDS, PAS, PTT, PR	At baseline and after the first and second treatments	After the first therapy session, significant differences in the PTT percentage of PR, and penetration-aspiration scale score were observed in the EBD group, compared with those in the RBS group. The regression analysis showed significant improvements in the PR after EBD compared with that after RBS
Marston (2016)	Non-RCT	Patients with idiopathic oropharyngeal dysphagia secondary to isolated CP bar Intervention : 23 Comparison (myotomy): 20	FOSS, complication rate	NA	Both endoscopic CP dilation and myotomy led to similar initial improvement in swallow function for patients with primary idiopathic CP bar; however, dilation is more likely to provide temporary benefit
Lan (2013)	Non-RCT	Brainstem stroke patient with dysphagia (n=30) Intervention (modified balloon dilatation therapy+regular therapy): 15 Comparison (regular therapy): 15	FOIS scores, manometry (UES resting pressure)	Before treatment and 1 day after the 3-wk treatment period	Dysphagia therapy with modified dilatation improved UES relaxation, strengthened pharyngeal propulsion, restored UES resting pressure and improved functional oral intake to a greater extent than regular therapy alone

CP, cricopharyngeal; RCT, randomized controlled trial; MEP, motor evoked potential; VFSS, videofluoroscopic swallowing study; NIHSS, National Institutes of Health Stroke Scale/Score; FOIS, functional oral intake scale; CPD, cricopharyngeal muscle dysfunction; EBD, endoscopic balloon dilatation; RBS, rehabilitative balloon swallowing; FDS, functional dysphagia scale; PAS, penetration-aspiration scale; PTT, pharyngeal transit time; PR, pharyngeal remnant; FOSS, Functional Outcome Swallowing Scale; NA, not available; UES, upper esophageal sphincter.

Participant comparability	+	+	+	+	+	+	+	+	+	+
Selection of participants	+	-	-	-	-	-	-	-	-	-
Confounding variables	+	+	+	+	+	+	+	+	+	?
Measurement of exposure	-	-	-	-	-	-	-	-	-	-
Blinding of outcome assessments	+	+	+	+	+	+	+	+	+	+
Outcome evaluation	+	+	+	+	+	+	+	+	+	+
Incomplete outcome data	+	+	+	+	+	+	+	+	+	+
Selective reporting	+	+	+	+	+	+	+	+	+	?
	Jo 2020	Lan 2013	Marston 2016							

Random sequence generation (selection bias)	+	+	+	+	+	+	+	+	+	+
Allocation concealment (selection bias)	-	-	-	-	-	-	-	-	-	-
Blinding of participants and personnel (performance bias)	-	-	-	-	-	-	-	-	-	-
Blinding of outcome assessment (detection bias)	-	-	-	-	-	-	-	-	-	-
Incomplete outcome data (attrition bias)	?	+	+	+	+	+	+	+	+	+
Selective reporting (reporting bias)	+	+	+	+	+	+	+	+	+	+
Other bias	+	+	+	+	+	+	+	+	+	+
	Bia 2015	Wei 2017								

Grade of recommendation

	YES	NO
Balance benefits and harms		0
Confidence in the estimates		0
Values and preference	0	
Resource use		0
Recommendation	yes	
Grade	Conditional	

KQ 12. Is the swallowing education program effective for improving swallowing function, reducing the risk of aspiration pneumonia, and improving diet?

Ist author	Design	Participants/intervention	Evaluation tool	Follow-up/duration	Outcomes
Chen (2018)	RCT	Oral cavity cancer patients (n=76) Intervention (swallowing exercise education program): 38 Comparison (normal care): 38	KPS score, MDADI, SSQ, HADS-depression subscale, FOIS	Baseline assessment (T0) and then 1, 2, 3, and 6-mo (T1, T2, T3, and T4) after treatment	Patients in the intervention group had significantly greater emotional dysphagia QOL compared to those in the comparison group
Yoon (2015)	RCT	Subjects who were diagnosed in dysphagia (n=20) Intervention (self swallowing exercise+NMES with traditional swallowing therapy): 10 Comparison (NMES with traditional swallowing therapy): 10	VDS, PAS	Pre- and post intervention	Self swallowing exercise and traditional swallowing therapy with NMES and traditional swallowing therapy with NMES are positive effect on swallowing function. The self swallowing exercise is not effective factor
Mashhour (2018)	Non-RCT	Head & neck cancer patients (n=60) Intervention (MD Anderson Cancer Center Swallowing Exercise Protocol): 30 Comparison (not mentioned): 30	SSQ	1st day, day 23 and last day of CRT	By the 3rd visit, severe dysphagia was higher in the comparison group. By the 3rd visit there was statistically significant difference between both groups in swallowing thin liquids, thick liquids and there was significant difference between control and study groups in all parameters
Cho (2017)	Non-RCT	Stroke patients with dysphagia (n=9) Intervention (bedside self-exercise) & comparison (pre-intervention): all patients	VDS	The pre- and post intervention	There were significant differences in both the oral and pharyngeal phases of the VDS before and after the intervention. Significant decrease in the oral phase. The pharyngeal phase also decreased significantly
Kang (2012)	Non-RCT	Stroke patients with dysphagia (n=50) Intervention (additional bedside exercise training): 25 Control group (conventional swallowing therapy): 25	New VFSS scale, FOIS, transition from the tube feeding to oral feeding, incidence of aspiration pneumonia, BDI, SS-QOL, FIM score	Before and after the treatment	Experimental group showed a significant improvement in the swallowing function at the oral phase in the new VFSS scale, in FOIS, and showed less depressive mood and better quality of life. No significant change in the incidence of aspiration pneumonia and the presence of tube feeding between the two groups

RCT, randomized controlled trial; KPS, Karnofsky Performance Status; MDADI, MD Anderson dysphagia inventory; SSQ, Sydney Swallowing Questionnaire; HADS, Hospital Anxiety and Depression Scale; FOIS, functional oral intake scale; QOL, quality of life; NMES, neuromuscular electrical stimulation; VDS, videofluoroscopic dysphagia scale; PAS, penetration-aspiration scale; CRT, chemo-radiotherapy; VFSS, videofluoroscopic swallowing study; BDI, Beck Depression Inventory; SS-QOL, Stroke Specific Quality of Life Scale; FIM, functional independent measurement.

Participant comparability	+
Selection of participants	?
Confounding variables	-
Measurement of exposure	-
Blinding of outcome assessments	?
Outcome evaluation	+
Incomplete outcome data	?
Selective reporting	?

Cho 2017

	Random sequence generation (selection bias)	Allocation concealment (selection bias)	Blinding of participants and personnel (performance bias)	Blinding of outcome assessment (detection bias)	Incomplete outcome data (attrition bias)	Selective reporting (reporting bias)	Other bias
Chen 2018	+	?	-	?	+	?	+
Kang 2012	-	-	-	-	?	?	+
Mashhour 2018	-	-	-	-	?	?	+
Yoon 2015	-	?	-	-	?	?	+

Grade of recommendation

	YES	NO
Balance benefits and harms	0	0
Confidence in the estimates	0	0
Values and preference	0	0
Resource use	yes	
Recommendation	Conditional	
Grade		

KQ 13.1. Is tDCS effective in improving swallowing function, reducing the risk of aspiration pneumonia, and improving diet?

Ist author	Design	Participants/intervention	Evaluation tool	Follow-up/duration	Outcomes
Sawan (2020)	RCT	Patients with acute or subacute ischemic stroke (n=40) Intervention (anodal tDCS):20 Comparison (sham tDCS):20	DOSS, VFSS finding	Before and immediately after the intervention	After treatment, there were significant differences between the study and control group for DOSS score and digital fluoroscopic findings
Wang (2020)	RCT	Brainstem stroke patients with cricopharyngeal muscle dysfunction (n=28) Intervention (anodal tDCS+catheter balloon dilatation+conventional swallowing therapy): 14 Comparison (sham tDCS +catheter balloon dilatation+conventional swallowing therapy): 14	FOIS, FDS, MBSImP, PESO	Before and immediately after the intervention	Significant improvement in the FDS, FOIS, and PESO scores immediately after the intervention. However, compared with the sham stimulation group, the anodal tDCS group showed greater improvements in the FDS, FOIS, and PESO scores
Pingue (2018)	RCT	Patients with poststroke dysphagia (n=40) Intervention (anodal tDCS over the damaged hemisphere plus cathodal stimulation over the contralateral one): 20 Comparison (sham stimulation during swallowing maneuvers): 20	DOSS, PAS	1 wk before and 1 wk after the treatment protocol	Among all variables recorded at baseline, only a subgroup of patients without nasogastric tube showed a significantly higher improvement with tDCS treatment vs. sham
Suntrup-Krueger (2018)	RCT	Acute dysphagic stroke patients (n=59) Intervention (anodal tDCS): 29 Comparison (sham tDCS): 30	FEDSS, clinical DSRS, FOIS	Before and immediately after the intervention	Patients treated with tDCS showed greater improvement in FEDSS than the sham group. Functional recovery was accompanied by a significant increase of activation in the contralateral swallowing network after real but not sham tDCS
Ahn (2017)	RCT	Patients with dysphagia for at least 6 mo post-stroke (n=26) Intervention (bihemispheric anodal tDCS): 13 Comparison (sham): 13	DOSS, VFSS finding	Before the first stimulation session and immediately after the last session	The intervention group showed a mean significant improvement in the DOSS immediately after all sessions. However, there was no mean significant improvement in the sham group. There was no significant difference between the 2 groups
Shigematsu (2013)	RCT	Patients who had dysphagia for at least 1 mo after stroke (n=20) Intervention (anodal tDCS): 10 Comparison (sham tDCS): 10	DOSS, VFSS finding	Before, immediately after, and 1 mo after the last session	The improvements in the anodal tDCS group were significantly greater than those in the sham tDCS group after the last session, and 1 mo after the last session
Yang (2012)	RCT	Patients with post-stroke dysphagia (n=16) Intervention (anodal tDCS): 8 Comparison (sham tDCS): 8	FDS	Baseline (Pre), just after intervention (Post 1), and 3 mo after intervention (Post 2)	After the intervention, FDS scores improved in both groups without significant differences. However, 3 mo after the intervention, anodal tDCS elicited greater improvement

Kumar (2011)	RCT	Patients with subacute unilateral hemispheric infarction (n=14) Intervention (anodal tDCS): 7 Comparison (sham tDCS): 7	DOSS	Before the first and after the last session of tDCS or sham	Patients who received anodal tDCS gained 2.60 points improvement in DOSS scores compared to patients in the sham stimulation group who showed an improvement of 1.25 points. 6 out of 7 (86%) patients in tDCS stimulation group gained at least 2 points improvement compared with 3 out of 7 (43%) patients in sham group
--------------	-----	---	------	---	---

tDCS, transcranial direct current electrical stimulation; RCT, randomized controlled trial; DOSS, Dysphagia Outcome and Severity Scale; VFSS, videofluoroscopic swallowing study; FOIS, functional oral intake scale; FDS, functional dysphagia scale; MBSImP, modified barium swallow impairment profile; PESO, pharyngoesophageal segmentation opening; PAS, penetration-aspiration scale; FEDSS, Fiberoptic Endoscopic Dysphagia Severity Scale; DRSR, Dysphagia Severity Rating Scale.

	Random sequence generation (selection bias)	Allocation concealment (selection bias)	Blinding of participants and personnel (performance bias)	Blinding of outcome assessment (detection bias)	Incomplete outcome data (attrition bias)	Selective reporting (reporting bias)	Other bias
Ahn 2017	+	?	?	+	?	?	+
Kumar 2011	?	?	?	+	+	?	+
Pingue 2018	+	?	-	?	+	?	+
Sawan 2020	?	?	-	?	?	?	+
Shigematsu 2013	+	?	-	+	+	?	+
Suntrup-Krueger 2018	+	?	+	+	+	?	+
Wang 2020	+	?	-	+	+	?	+
Yang 2012	?	?	?	+	+	?	+

Grade of recommendation

	YES	NO
Balance benefits and harms	0	
Confidence in the estimates		0
Values and preference	0	
Resource use		0
Recommendation	yes	
Grade	Conditional	

QQ 13.2. Is rTMS effective for improving the swallowing function and diet, as well as reducing risk of aspiration pneumonia?

Ist author	Design	Participants/intervention	Evaluation tool	Follow-up/duration	Outcomes
Tarameshlu (2019)	RCT	Patients with poststroke dysphagia (n=18) Intervention 1 (rTMS): 6 Comparison (traditional dysphagia therapy): 6 Intervention 2 (combined intervention): 6	MASA, FOIS	After the end of the 5th, 10th, 15th, and 18th session	The improvements achieved in all outcomes were significantly greater in the combined intervention group than those of the traditional dysphagia therapy and rTMS groups
Ünlüer (2019)	RCT	Mono-hemispheric post-stroke patients with dysphagia (n=28) Intervention (conventional dysphagia rehabilitation+1 Hz rTMS to unaffected hemisphere): 15 Comparison (conventional dysphagia rehabilitation): 13	PAS, nutritional status, the SWAL-QOL questionnaire, the SAFE, oral parameters of VFSS (tongue retraction, delayed swallowing reflex, hyolaryngeal elevation, residue)	After the treatment, 1 mo and 3 mo	rTMS did not enhance the swallowing function when compared conventional dysphagia rehabilitation. Therefore, the application of 1 Hz rTMS should be reconsidered to improve swallowing function in the chronic period
Zhang (2019)	RCT	Patients with their first-ever stroke complicated with dysphagia (n=32) Intervention 1 (ipsi-rTMS/NMES): 16 Intervention 2 (contra-rTMS/NMES): 16 Intervention 3 (Bi-rTMS/NMES): 16 Comparison (sham-rTMS/NMES): 16	Amplitude of the MEP at the mylohyoid muscle cortical representative area, SSA, DD	After the treatment, 1 mo	Bi-rTMS/NMES produced higher cortical excitability and better swallowing function recovery. Compared with NMES alone, unilateral rTMS plus NMES had additional effects on cortical excitability and rehabilitation of dysphagia, but there were no differences between the Contra-rTMS/NMES and Ipsi-rTMS/NMES groups
Cheng (2017)	RCT	Participants with chronic post-stroke dysphagia (n=15) Intervention (active rTMS): 11 Comparison (sham): 4	VFSS, swallowing-related quality-of-life questionnaire, maximum tongue strength measurement	2 mo, 6 mo, and 12 mo	No statistically significant effects were identified for any outcome measures
Park (2017)	RCT	Patients with post-stroke dysphagia (n=35) Intervention 1 (bilateral stimulation): 12 Intervention 2 (unilateral stimulation): 11 Comparison (sham stimulation): 12	CDS, DOSS, PAS, VDS, myohyoid MEP	After the intervention (T1), 3 wk (T2)	There were significant time and intervention interaction effects in the CDS, DOSS, PAS, and VDS scores. The change in CDS scores at T1 and T2 showed a significantly higher improvement in the bilateral stimulation group than in two other groups. There was a significantly larger change in the DOSS, PAS, and VDS scores at T1 in the bilateral stimulation group than in two other groups
Du (2016)	RCT	Patients with poststroke dysphagia (n=40) Intervention 1 (3Hz rTMS): 15 Intervention 2 (1Hz rTMS): 13 Comparison (sham rTMS): 12	SSA, the water swallow test, the DD, BI score, mRS, mylohyoid MEPs evoked from both hemispheres	After the treatment, 1 mo, 2 mo, and 3 mo	A significantly greater improvement in swallowing function as well as functional disability was observed after real rTMS when compared with sham rTMS, which remained 3 mo after the end of the treatment sessions

Lim (2014)	RCT	Subacute, unilateral hemispheric stroke patients with dysphagia (n=47) Intervention 1 (rTMS): 14 Intervention 2 (NMES): 18 Comparison (conventional dysphagia therapy): 17	FDS, PTT, PAS, ASHA NOMS swallowing scale	After 2 wk, and after 4 wk of treatments	Mean changes in FDS and PAS for liquid during first 2 wk in the rTMS and NMES groups were significantly higher than those in the CDT group, but no significant differences were found between the rTMS and NMES group
Park (2013)	RCT	Patients with unilateral hemispheric stroke oropharyngeal dysphagia (n=18) Intervention(5 Hz rTMS over contralateral hemisphere); 9 Comparison (sham): 9	VDS, PAS	After the treatment, 2 wk	VDS and PAS scores in the intervention group were significantly reduced just after 2 wk intervention. This effect lasted for up to 2 wk after treatment. However, there was no change in the comparison group
Kim (2011)	RCT	Patients with brain injury and dysphagia Intervention 1 (high frequency stimulation): 10 Intervention 2 (low frequency stimulation): 10 Comparison (sham stimulation): 10	VDS, PAS, ASHA NOMS swallowing scale	After treatment	FDS and PAS scores improved significantly in the low frequency group after rTMS, and ASHA NOMS scores improved in the sham and low frequency groups. FDS and PAS scores improved significantly in the low frequency group compared to those in the other groups
Khedr (2010)	RCT	Patients with lateral medullary syndrome and brainstem infarction (n=22) Intervention (active rTMS): 11 Comparison (sham): 11	Dysphagia rating scale, hand grip strength, NIHSS, BI scales	After the treatment, 1 mo, 2 mo	Active rTMS improved dysphagia compared with sham rTMS in both groups of patients, the lateral medullary infarction group also improved the scores in the Barthel Index. All improvements were maintained over 2 mo
Khedr (2009)	RCT	Patients with post-stroke dysphagia due to monohemispheric stroke (n=26) Intervention (real rTMS): 14 Comparison (sham): 12	DD, BI, resting motor threshold of healthy side and oesophageal MEP's amplitude and magnitude, grip strength	After the treatment, 1 mo, 2 mo	Real rTMS led to a significantly greater improvement compared with sham in dysphagia and motor disability that was maintained over 2 mo of follow-up. This was accompanied by a significant increase in the amplitude of the oesophageal MEP evoked from either the stroke or non-stroke hemisphere

rTMS, repetitive transcranial magnetic stimulation; RCT, randomized controlled trial; MASA, Mann Assessment of Swallowing Ability; FOIS, functional oral intake scale; PAS, penetration-aspiration scale; SWAL-QOL, swallowing-related quality of life; SAFE, Swallowing Ability and Function Evaluation; VFSS, videofluoroscopic swallowing study; NMES, neuromuscular electrical stimulation; MEP, motor evoked potential; SSA, Standardized Swallowing Assessment; DD, degree of dysphagia; CDS, Clinical Dysphagia Scale; DOSS, Dysphagia Outcome and Severity Scale; VDS, videofluoroscopic dysphagia scale; mRS, modified Rankin Scale; FDS, functional dysphagia scale; PTT, pharyngeal transit time; ASHA NOMS, American Speech-Language Hearing Association National Outcomes Measurement System; CDT, conventional dysphagia therapy; NIHSS, National Institutes of Health Stroke Scale/Score; BI, Barthel Index Scale.

	Random sequence generation (selection bias)	Allocation concealment (selection bias)	Blinding of participants and personnel (performance bias)	Blinding of outcome assessment (detection bias)	Incomplete outcome data (attrition bias)	Selective reporting (reporting bias)	Other bias
Cheng 2017	+	?	+	+	-	-	+
Du 2016	+	+	+	+	+	+	+
Khedr 2009	?	?	-	-	+	?	+
Khedr 2010	?	?	-	+	?	?	+
Kim 2011	?	?	-	+	+	?	+
Lim 2014	+	?	-	+	+	?	+
Park 2013	+	+	+	+	+	?	+
Park 2017	?	?	-	+	+	?	+
Tarameshlu 2019	+	+	+	+	+	+	+
Ünlüer 2019	+	+	-	+	+	?	+
Zhang 2019	+	?	?	+	+	?	+

Grade of recommendation

	YES	NO
Balance benefits and harms	0	
Confidence in the estimates	0	0
Values and preference	0	
Resource use		0
Recommendation	yes	
Grade	Conditional	

KQ 14.1. Does enteral tube feeding improve the clinical course, survival, or nutritional status of patients who are likely to have oropharyngeal dysphagia for a long period of time?

Ist author	Design	Participants/intervention	Evaluation tool	Follow-up/duration	Outcomes
Axelsson (2017)	RCT	Patients with advanced head & neck cancer (n=134) Intervention (prophylactic percutaneous endoscopic gastrostomy): 64 Comparison (clinical nutritional support): 70	EORTC-QLQ-H&N35	8 yr	There was no significant difference in swallowing function between the groups after 12 mo, 24 mo, and 8 yr based on the EORTCQLQ-H&N35, the oral intake scale, tube dependence, esophageal intervention, weight, and BMI
Brown (2017)	RCT	Patients with head and neck cancer (n=122) Intervention (prophylactic percutaneous endoscopic gastrostomy): 56 Comparison (standard care): 66	Percentage weight loss	3 mo post-treatment	The early intervention did not improve outcomes, but poor adherence to nutrition recommendations impacted on potential outcomes
Silander (2013)	RCT	Patients with oral or pharyngeal cancer or neck lymph node metastases (n=127) Intervention (prophylactic percutaneous endoscopic gastrostomy): 62 Comparison (standard nutritional care): 65	Weight, dysphagia, energy intake	At inclusion, 1, 2, 3, 6, 12, and 24 mo	No significant differences between groups were found for weight. There were no significant differences between the two groups at those time points but the study group's problems with solid food had increased compared with at time of diagnosis
Silander (2012)	RCT	Patients with advanced head and neck cancer (n=134) Intervention (prophylactic percutaneous endoscopic gastrostomy): 64 Comparison (clinical praxis): 70	Weight, BMI, need for HRQOL, EORTC QLQ-C30, QLQ-H&N35	At inclusion, 1, 2, 3, 6, 12, and 24 mo	Prophylactic PEG was associated with significantly earlier start and longer use of enteral nutrition, fewer malnourished patients over time, and improved HRQOL at 6 mo posttreatment start
Salas (2009)	RCT	Squamous cell head and neck carcinoma (n=35) Intervention (prophylactic (proactive) percutaneous gastrostomy): 21 Comparison (no systematic gastrostomy): 18	SF36, EORTC questionnaires	Baseline (T0), first day of the 4th wk of radiotherapy (T1), at the end of the radiotherapy (T2), 6-mo post-inclusion (T3)	Prophylactic gastrostomy improves post-treatment quality of life for unresectable head and neck cancer patients, after adjusting for other potential predictive quality of life factors
Dennis (2005)	RCT	Dysphagic stroke patients (n=859) Intervention (early tube feeding): 429 Comparison (avoid tube feeding for at least 7 days): 430	Primary outcome: death or poor outcome, overall survival Other: place of residence and EUROQoL score, compliance with treatment, length of hospital stay, in-hospital complications, causes of death	6 mo	Early tube feeding might reduce case fatality, but at the expense of increasing the proportion surviving with poor outcome

RCT, randomized controlled trial; EORTC, European Organization for Research and Treatment of Cancer; QLQ-H&N35, Quality of Life Questionnaire-Core 30 Head and Neck 35-questions; BMI, body mass index; HRQOL, hospitalization, and health-related quality of life; QLQ-C30, Quality of Life Questionnaire-Core 30-questions; PEG, percutaneous endoscopic gastrostomy; SF36, Short Form 36.

	Random sequence generation (selection bias)	Allocation concealment (selection bias)	Blinding of participants and personnel (performance bias)	Blinding of outcome assessment (detection bias)	Incomplete outcome data (attrition bias)	Selective reporting (reporting bias)	Other bias
Avelsson 2017	+	+	?	-	-	+	?
Brown 2017	+	+	?	?	-	+	-
Dennis 2005	+	+	-	+	+	+	?
Salas 2009	+	+	-	-	+	?	?
Silander 2012	+	+	?	-	-	+	?
Silander 2013	?	-	-	+	+	-	?

Grade of recommendation

	YES	NO
Balance benefits and harms	0	0
Confidence in the estimates	0	0
Values and preference	0	0
Resource use	0	0
Recommendation	yes	
Grade	Conditional	

KQ 14.2. Does enteral tube feeding improve the clinical course, survival, or nutritional status of patients who are likely to have oropharyngeal dysphagia for a long period of time?

Ist author	Design	Participants/intervention	Evaluation tool	Follow-up/ duration	Outcomes
Corry (2009)	RCT	Patients with squamous cell carcinoma of the head & neck planned for curative radiotherapy or chemoradiation (n=33) Intervention (percutaneous endoscopic gastrostomy): 15 Comparison (NGT): 18	Nutritional status (absolute weight, weight loss, upper arm circumference, triceps skin fold thickness), complication rates, patient satisfaction (modified QoL questionnaire), cost	At 6 wk & 6 mo post treatment	There were more tube dislodgements in the NGT group, but we found no difference in patients' assessment of their overall physical condition or overall QoL. The cost of PEG tubes is significantly greater and there was significantly longer duration of use of the PEG tubes compared with NGT
Dennis (2006)	RCT	Patients admitted to hospital with a recent stroke (n=281) Intervention (enteral tube feeding via percutaneous endoscopic gastrostomy): 128 Comparison (enteral tube feeding via nasogastric tube): 153	Death or poor outcome, overall survival, place of residence, EUROQoL score, compliance with treatment, length of hospital stay, in-hospital complications, causes of death	6 mo	PEG feeding was associated with an increase of borderline significance in absolute risk of death or poor outcome. The rate of gastrointestinal haemorrhage was higher with nasogastric rather than PEG tube
Hamidon (2006)	RCT	Patients with acute dysphagic stroke (n=18) Intervention (percutaneous endoscopic gastrostomy): 8 Comparison (NGT): 10	Nutritional status (skin-fold thickness & mid-arm circumference of non-paralyzed limb, serum albumin level), treatment failure rate	4 wk	PEG tube feeding is more effective than NGT feeding in improving the nutritional status of patients with dysphagic stroke
Norton (1996)	RCT	Patients with persisting dysphagia at 14 day after acute stroke (n=30) Intervention (percutaneous endoscopic gastrostomy): 16 Comparison (NGT feeding): 14	Six wk mortality, amount of feed administered, change in nutritional state, treatment failure, length of hospital stay	6 wk	Early gastrostomy feeding after acute dysphagic stroke is associated with a significant reduction in mortality at 6 wk. The use of a gastrostomy results in improved nutritional state compared with nasogastric feeding and will improve the prospects of early hospital discharge
Park (1992)	RCT	Patients with persisting neurological dysphagia (n=40) Intervention (percutaneous endoscopic gastrostomy): 20 Comparison (NGT feeding): 20	Number of treatment failures, duration of feeding, intake of liquid diets, complications, nutritional status at end of trial	28 day	Percutaneous endoscopic gastrostomy tube feeding is a safe and effective method of providing long term enteral nutrition to patients with neurological dysphagia and offers important advantages over NGT feeding

RCT, randomized controlled trial; NGT, nasogastric tube; QoL, quality of life; PEG, percutaneous endoscopic gastrostomy.

	Random sequence generation (selection bias)	Allocation concealment (selection bias)	Blinding of participants and personnel (performance bias)	Blinding of outcome assessment (detection bias)	Incomplete outcome data (attrition bias)	Selective reporting (reporting bias)	Other bias
Corry 2008	+	+	-	-	-	?	?
Dennis 2006	+	+	-	+	+	+	?
Hamidon 2006	+	+	-	-	+	+	?
Norton 1996	?	+	-	-	-	?	?
Park 1992	+	+	-	-	-	?	?

Grade of recommendation

	YES	NO
Balance benefits and harms	0	0
Confidence in the estimates	0	0
Values and preference	0	0
Resource use	0	0
Recommendation	yes	no
Grade	Conditional	Conditional

KQ 15. Does texture modification of food or liquid affect the clinical course (nutrition status or dehydration) of dysphagia

Ist author	Design	Participants/intervention	Evaluation tool	Follow-up/duration	Outcomes
Kyodo (2020)	RCT	Patients with moderate to severe dysphagia (n=124) Intervention (pureed rice with a gelling agent): 62 Comparison (pureed rice without a gelling agent): 62 (cross over)	Pharyngeal residuals using an endoscopic scoring system (endoscopic cyclic ingestion score), sense of material remaining in the throat following swallowing	NA	Pureed diets containing a gelling agent may reduce the risk of aspiration pneumonia possibly by decreasing pharyngeal residues in elderly patients with moderate to severe dysphagia
Kenedi (2019)	RCT	Acute trauma and stroke patients (n=104) Intervention (access to water and ice chips): 52 Comparison (no access to thin liquids): 52	Positive clinical indicators: number of diet upgrades, days to a diet upgrade, days in the study Negative clinical indicators: intubation, pneumonia, diet downgrade	Daily during the business wk	No significant group differences in positive outcomes were found. Negative clinical indicators were too infrequent to allow for statistical comparison of the 2 groups
Murray (2016)	RCT	Patients with known thin liquid aspiration post stroke (n=14) Intervention (water protocol): 8 Comparison (thickened liquid only): 6	Average daily beverage intake, hydration status (BUN/Cr)	14 day	The water protocol did not result in an increase in total fluid intake. However, those who were permitted water had an improving trajectory of hydration levels compared to those on thickened liquids only
Karagiannis (2011)	RCT	Patients with oropharyngeal dysphagia (n=76) Intervention (water+thickened): 42 Comparison (thickened only): 34	Lung related complications (body temperature, bibasal crepitations), daily fluid intake, quality of life survey	8 day (3 pre-phase day, 5 post-interventions)	A significantly increased risk in the development lung complications in patients given access to water compared to the control group. Increased total fluid intake in the patients allowed access to water, and the quality of life surveys, albeit from a limited number of patients
Diniz (2009)	RCT	Inpatients diagnosed with acute phase or prior stroke (n=61) Intervention (spoon-thick) & comparison (liquid): all patients, crossover	Nasoendoscopy, clinical assessment of swallowing	NA	The incidence of aspiration diagnosed by nasoendoscopy was significantly related to decreased thickness. The use of a spoon-thick consistency reduced the risk of aspiration compared with the liquid consistency
Robbins (2008)	RCT	Patients age 50 yr or older with dementia or Parkinson disease who aspirated thin liquids (n=151) Intervention (nectar-thick or honey-thick): 256 Comparison (chin-down posture): 259	Pneumonia diagnosed by chest radiography or by the presence of 3 respiratory indicators	3 mo	No definitive conclusions about the superiority of any of the tested interventions can be made

Goulding (2000)	RCT	Dysphagic stroke patients (n=46) Intervention (using a viscometer): 23 Comparison (subjective judgement for viscosity): 23	Pulmonary aspiration assessed clinically and with pulse oxymetry, residual volume after 75 mL fluid consumption	7 day	Fluids prepared by subjectively assessing the amount of thickener tend to have a higher viscosity than those prepared using the viscometer However, the higher viscosity does not appear to protect against pulmonary aspiration and may lead to a reduced fluid intake
Garon (1997)	RCT	Patients on a stroke rehabilitation unit (n=20) Intervention (thickened fluid+free access to water): 10 Comparison (thickened fluid only): 10	Aspiration pneumonia, dehydration, amounts of thickened liquids and water consumed, length of time to document aspiration on X-ray	Based on clinical observation rather than on a fixed time frame 30 day	No aspiration pneumonia, dehydration in either group. Comparison group had a higher mean of fluid intake of thickened liquid than intervention group

RCT, randomized controlled trial; NA, not available; BUN/Cr, blood urea nitrogen/creatinine ratio.

	Random sequence generation (selection bias)	Allocation concealment (selection bias)	Blinding of participants and personnel (performance bias)	Blinding of outcome assessment (detection bias)	Incomplete outcome data (attrition bias)	Selective reporting (reporting bias)	Other bias
Diniz 2009	+	-	?	?	?	?	?
Garon 1997	?	?	-	?	?	?	-
Goulding 2000	+	+	?	+	?	?	?
Karagiannis 2011	+	+	-	+	?	+	?
Kenedi 2019	+	-	?	-	+	?	?
Kyodo 2020	+	+	?	?	?	+	?
Murray 2016	+	+	-	-	?	?	-
Robbins 2008	+	+	-	?	+	+	?

Grade of recommendation

	YES	NO
Balance benefits and harms	O	
Confidence in the estimates		O
Values and preference	O	
Resource use	O	
Recommendation	yes	
Grade	Conditional	

Q16. Does nutrition intervention improve intake or nutritional status in patients with oropharyngeal dysphagia?

Ist author	Design	Participants/intervention	Evaluation tool	Follow-up/duration	Outcomes
Germain (2006)	RCT	Institutionalized elders (n=17) Intervention (dysphagia-specific nutrition care program): 8 Comparison (traditional modified-texture diet): 9	Macronutrient and micronutrient intake, weight, BMI	Baseline, 6 wk, and 12 wk	The weight, intake of energy, proteins, fats, total saturated fats, monounsaturated fats, potassium, magnesium, calcium, phosphorus, zinc, vitamin B-2, and vitamin D in the treated group increased compared to the control group
Reyes-Torres (2019)	RCT	Older adults with oropharyngeal dysphagia (n=40) Intervention (modified consistency diet, with a nectar or pudding viscosity): 20 Comparison (standard treatment): 20	Forearm and calf circumference, MNA questionnaire, 24-h multiple-step recall and Food Processor Nutrition Analysis® software, BIA, grasp power	Baseline, 6 wk, and 12 wk	The consumption of energy and protein, as well as phase angle, body weight, and handgrip strength increased in the intervention group. In control group there were no changes
Taylor (2006)	RCT	Elderly residents with dysphagia (n=62) & Intervention (small and frequent meals) & comparison (regular menu and portion sizes): all participants, crossover	Food and fluid intake data	Post-intervention	Average energy intakes were similar between the three- and five-meal patterns; fluid intake was higher with five meals
Shimazu (2021)	Non-RCT	Patients with stroke (n=426) Intervention (high-frequency dietary prescription, ≥5 frequencies/day): 233 Comparison (low-frequency dietary prescription): 193	FIM motor domain score, SMI, LOS, presence of dysphagia at discharge	Admission, discharge	Frequent and individualized nutritional support is associated with improved nutritional status, physical function, and dysphagia after stroke
Shimizu (2021)	Non-RCT	Older patients with sarcopenic dysphagia (n=110) Intervention (provided energy ≥30 kcal/IBW/kg/day): 69 Comparison (provided energy <30 kcal/IBW/kg/day): 41	FILS score, FIM	Admission, discharge	The FILS and the rates of achieved MCID of the FIM at discharge were significantly higher in the intervention group. A high provided energy for patients with sarcopenic dysphagia may improve swallowing ability and produce clinically meaningful functional outcomes
Zanini (2017)	Non-RCT	Institutionalised dysphagic older people (n=479) Intervention (NUTRICARE, a dedicated food programme) & comparison (6 mo before the intervention): all participants	Plasmatic biochemical nutritional parameters (total protein, albumin, transferrin, lymphocytes, creatinine, total and HDL cholesterol, triglycerides), MNA-SF	6 mo before intervention, pre-intervention, every 8 wk for 6 mo after intervention	The NUTRICARE food programme with a adequate proteins, calories, balanced nutritional and bromatological properties, and appropriate texture and palatability significantly improved the nutritional, biochemical and functional profile
Wright (2008)	Non-RCT	Elderly dysphagic patients in hospital (n=46) Intervention (individualized feeding assistance): 16 Comparison (retrospective control): 30	Mean daily food intake	3 day average	The group with targeted assistance had higher intakes of energy and protein from both meals and supplements combined compared to the controls

Martens (1990)	Non-RCT	Neurologically impaired patients with dysphagia (n=31)	Weights, daily calorie counts, chest X-ray	Before intervention: A significant weight gain and increase in caloric intake occurred in the treated group. August–December, 1987
		Intervention (individualized dysphagia management program): 16		No incidence of aspiration pneumonia was reported in either group
		Comparison (before intervention): 15		

RCT, randomized controlled trial; BMI, body mass index; MNA, Mini Nutritional Assessment; BIA, bioelectrical impedance analysis; FIM, Functional Independence Measure; SMI, skeletal muscle mass index; LOS, length of hospital stay; IBW, ideal body weight; FILS, Food intake LEVEL Scale; FIM, Functional Independence Measure; MCI, minimal clinically important difference; HDL, high-density lipoprotein; MNA-SF, Mini Nutritional Assessment-Short Form.

Germain 2006	+	+	+	+	+	+	?
Reyes-Torres 2019	+	?	+	+	+	+	?
Taylor 2006	?	+	+	+	+	+	?
	Random sequence generation (selection bias)	Allocation concealment (selection bias)	Blinding of participants and personnel (performance bias)	Blinding of outcome assessment (detection bias)	Incomplete outcome data (attrition bias)	Selective reporting (reporting bias)	Other bias

Martens 1990	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Shimazu 2021	-	+	+	+	+	+	+	+	+	+	+	+	+	+
Shimizu 2021	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Wright 2008	-	+	+	+	+	+	+	+	+	+	+	+	+	+
Zanini 2017	-	+	+	+	+	+	+	+	+	+	+	+	+	+
	Participant comparability	Selection of participants	Confounding variables	Measurement of exposure	Blinding of outcome assessments	Outcome evaluation	Incomplete outcome data	Selective reporting						

Level of evidence

Study design	No. of studies	Risk of bias	Inconsistency	Indirectness	Imprecision	Publication bias	Level of evidence	Importance
RCT	3	0	0	0	-1	0	Moderate	7
Non-RCT	5	0	-1	0	0	0	Low	7

Grade of recommendation

	YES	NO
Balance benefits and harms	O	
Confidence in the estimates		O
Values and preference	O	
Resource use	O	
Recommendation	yes	
Grade	Strong	

KQ 17. Are the incidence and mortality rates of AP higher in patients with oropharyngeal dysphagia compared with those without oropharyngeal dysphagia?

Ist author	Design	Participants/intervention	Evaluation tool	Follow-up/duration	Outcomes
Labelt (2021)	Non-RCT	IIM patients who had received FEES (n=71) Intervention & comparison: NA	AP, death	During the 2009–2019 study period or the documented period included therein	Dysphagia severity was an independent predictor for pneumonia
Kim (2020)	Non-RCT	Cricopharyngeal dysfunction patient (n=8) Intervention & comparison: NA	Development of AP during the 3 mo before or after the initial VFSS	3 mo after the initial VFSS	Aspiration during the 2-mL thick-liquid and thin-liquid trials showed significant between pneumonia group and non-pneumonia group. A PAS level 8 was significantly more common in the pneumonia group
Feng (2019)	Non-RCT	Stroke patients from Taiwan’s NHRD (n=1,200) Intervention (dysphagia group): 610 Comparison (nondysphagia group): 610	Diagnosis of ICD-9-CM 507 (pneumonitis due to solids and liquids)	From January 1, 2000 to December 31, 2005	The dysphagia group was more likely to develop AP than the nondysphagia group. The mortality rate in the dysphagia group was significantly higher than that in the nondysphagia group
Lo (2019)	Non-RCT	From Taiwan’s NHRD (n=27,916) Intervention (with newly diagnosed dysphagia): 6,979 Comparison (without dysphagia): 20,937	AP identified according to ICD-9-CM coding (481, 482.0, and 483.0), overall mortality	Between January 2000 and December 2009	Dysphagia was highly associated with an increased risk of AP. A significant difference in the incidence of mortality among dysphagia patients compared with that of the control group
Xu (2019)	Non-RCT	Elderly hospitalization stroke patients (n=196) Intervention (MWST-abnormal): 44 Comparison (MWST-normal): 152	AP	Admission–discharge	Through multivariable logistic regression analysis, dysphagia were correlated with the AP
Kawai (2017)	Non-RCT	Patients with head & neck cancer who received definitive concurrent chemoradiotherapy or bio-radiotherapy (n=305) Intervention (the worst dysphagia grade during treatment 3–4): 133 Comparison (the worst dysphagia grade during treatment 0–2): 172	AP after chemoradiotherapy or bio-radiotherapy	Between August 2006 and April 2015	The worst dysphagia grade during treatment was not statistically significant and was not a risk factor for AP
Manabe (2015)	Non-RCT	Secondary data from a nationwide questionnaire survey conducted by the JAGHSF (n=9,930) Intervention & comparison: NA	Episode of AP in the previous 3 mo	NA	The deterioration of swallowing function were associated with the incidence of AP. Impaired swallowing function were observed significantly more often in subjects with AP than in those without AP

Hunter (2014)	Non-RCT Patients with stage III to IV oropharyngeal cancer (n=72) Intervention & comparison: NA	Episodes of AP	2 yr posttherapy	Posttherapy aspiration found on videofluoroscopy, videofluoroscopy-based silent aspiration, high penetration-aspiration score, and the number of aspiration events recorded on a single videofluoroscopy study were all statistically significant predictors of AP
Waiila (2013)	Non-RCT Patients with first-ever and recurrent strokes (n=524) Intervention & comparison: NA	AP during hospital stay and follow-up	At discharge	The factors that were independently associated with the development of AP include dysphagia and dysphasia
Langmore (1998)	Non-RCT Subjects recruited from the outpatient clinics (n=189) Intervention & comparison: NA	AP	Up to 4 yr for an outcome of verified AP	Dysphagia was concluded to be an important risk for AP, but generally not sufficient to cause pneumonia unless other risk factors are present as well
Kim (1993)	non RCT Patients with ischemic stroke (n=173) Intervention (with dysphagia): 65 Comparison (without dysphagia): 108	AP	Admission-discharge	A higher incidence of AP was found in patients with dysphagia compared to patients without dysphagia

AP, aspiration pneumonia; RCT, randomized controlled trial; IIM, idiopathic inflammatory myopathy; FEES, fiberoptic endoscopic examination of swallowing; NA, not available; VFSS, videofluoroscopic swallowing study; PAS, penetration-aspiration scale; NHRD, National Health Insurance Research Database; ICD-9-CM, International Classification of Diseases, Ninth Revision, Clinical Modification; MWST, modified water swallowing test; JAGHSE, Japanese Association of Geriatric Health Services Facilities.

	Participant comparability	Selecting of participants	Confounding variables	Measurement of exposure	Blinding of outcome assessments	Outcome evaluation	Incomplete outcome data	Selective reporting
Feng 2019	+	+	+	?	+	+	+	+
Hunter 2014	+	+	+	+	+	+	-	+
Kawai 2017	+	+	+	?	-	+	+	+
Kim 1993	-	+	-	+	+	?	+	+
Kim 2020	?	+	+	+	-	+	+	+
Labelt 2021	+	+	+	+	-	+	-	+
Langmore 1998	?	+	+	+	+	-	+	+
Lo 2019	+	+	?	-	+	+	?	+
Manabe 2015	+	+	+	-	+	+	?	+
Wattia 2013	?	+	+	+	+	+	+	+
Xu 2019	+	+	+	+	+	+	+	+

Grade of recommendation

	YES	NO
Balance benefits and harms	0	
Confidence in the estimates	0	
Values and preference	0	
Resource use	0	
Recommendation	yes	
Grade	Strong	

KQ 18. Is the oral care program effective for improving oral health and food intake?

1st author	Design	Participants/intervention	Evaluation tool	Follow-up/duration	Outcomes
Chen (2019)	RCT	Patients with dysphagia following a first-time stroke (n=66) Intervention (oral health programme+usual oral care and manual): 33 Comparison (usual oral care and manual): 33	OHAT, FOIS scores, MNA-SF scores, nasogastric tube removal rates	2 and 3 wk after swallowing treatment	The oral care group showed significant improvement in OHAT than control group, but no significant differences in FOIS, MNA-SF and nasogastric removal rate
Chippis (2014)	RCT	Poststroke patients (n=51) Intervention (oral care twice a day including tooth brushing, tongue brushing, flossing, mouth rinse, and lip care): 29 Comparison (usual oral care): 22	Oral cavity assessments (revised-THROAT), MASA, FOIS, microbiological methods	Revised THROAT & microbiological methods: 1,5, and 10 day MASA : 1 and 10 day FOIS : 2 and 10 day	Although not statistically significant, overall prevalence of methicillin-resistant Staphylococcus aureus and methicillin-sensitive S. aureus colonization in the control group almost doubled, while colonization in the intervention group decreased

RCT, randomized controlled trial; OHAT, oral health assessment tool; FOIS, functional oral intake scale; MNA-SF, Mini Nutritional Assessment-Short Form; THROAT, The Holistic Reliable Oral Assessment Tool; MASA, Mann Assessment of Swallowing Ability.

	Random sequence generation (selection bias)	Allocation concealment (selection bias)	Blinding of participants and personnel (performance bias)	Blinding of outcome assessment (detection bias)	Incomplete outcome data (attrition bias)	Selective reporting (reporting bias)	Other bias
Chen 2019	+	?	+	+	+	+	+
Chippis 2014	+	+	+	+	-	+	+

Grade of recommendation

	YES	NO
Balance benefits and harms	O	
Confidence in the estimates		O
Values and preference	O	
Resource use	O	
Recommendation	yes	
Grade	Strong	

KQ 19. Is the multidisciplinary team approach (doctor, nurse, therapist, nurse, etc.) effective for reducing complications (such as mortality, pneumonia, and other respiratory infections) in patients with oropharyngeal dysphagia?

1st author	Design	Participants/intervention	Evaluation tool	Follow-up/duration	Outcomes
Zheng (2014)	RCT	Stroke patients with dysphagia (n=88) Intervention (a multidisciplinary rehabilitation team): 44 Comparison (conventional rehabilitation program): 44	Functional assessment of dysphagia	After 2 wk	The intervention group showed a significant improvement in the swallowing function and total effective rate than that of the control group
Shimazu (2021)	Non-RCT	Patients with stroke (n=426) Intervention (high frequency group): 233 Comparison (low frequency group): 193	SMI, FIM motor score, dysphagia status assessed using the FILS, LOS	Admission–discharge	Intensive nutritional support through multidisciplinary discussion plays a central role in the prevention and management of malnutrition to maximize the improvement of patient outcomes
Starmer (2017)	Non-RCT	Surveys from head and neck cancer patients Intervention (a dedicated head and neck speech and swallowing rehabilitation program): 271 surveys Comparison (prior to establishment of the intervention): 199 surveys	Physician behavior regarding speech and swallowing outcomes (as measured by discussion of function, providing suggestions regarding function, and referral to speech-language pathology services)	1 yr following establishment	Integration of speech and swallowing rehabilitation into head and neck cancer programs is associated with increased physician focus on functional outcomes and greater patient satisfaction in regard to swallowing function
Aoki (2016)	Non-RCT	Acute stroke patients (n=305) Intervention (after team organization; post period): 173 Comparison (before team organization; prior period): 132	Pneumonia, professional oral care, swallowing evaluations (videofluoroscopic examination of swallowing)	Prior period: April 2009 to March 2011 Post period: April 2011 to March 2014	The multidisciplinary participatory swallowing team effectively decreased the pneumonia onset in acute stroke patients
Gandolfi (2014)	Non-RCT	Patients with post-stroke dysphagia (n=84) Intervention (treatment under a standardized diagnostic and rehabilitative multidisciplinary protocol): 39 Comparison (non-treated group): 45	Death, pneumonia, need for respiratory support, form of nutrition support	From 2004 to 2008, every 6 mo	The multidisciplinary protocol applied in this study offers an effective model of management of post-stroke dysphagia

RCT, randomized controlled trial; SMI, skeletal muscle mass index; FIM, functional independent measurement; FILS, Food intake LEVEL Scale; LOS, length of hospital stay.

Participant comparability	Aoki 2016	Gandolfi 2014	Shimazu 2021	Starmer 2017
Selection of participants	+	+	+	+
Confounding variables	-	+	?	-
Measurement of exposure	?	?	+	+
Blinding of outcome assessments	?	?	+	?
Outcome evaluation	+	+	+	+
Incomplete outcome data	+	+	+	?
Selective reporting	+	+	+	+

Random sequence generation (selection bias)	+
Allocation concealment (selection bias)	-
Blinding of participants and personnel (performance bias)	?
Blinding of outcome assessment (detection bias)	-
Incomplete outcome data (attrition bias)	+
Selective reporting (reporting bias)	+
Other bias	+

Zheng 2014

Grade of recommendation

	YES	NO
Balance benefits and harms	O	O
Confidence in the estimates	O	O
Values and preference	O	O
Resource use	yes	
Recommendation	Conditional	