ORIGINAL ARTICLE

Can an Oral Mechanism Examination Contribute to the Assessment of Odds of Aspiration?

Steven B. Leder · Debra M. Suiter · Joseph Murray · Alfred W. Rademaker

Abstract Use of an oral mechanism examination is ubiquitous and long-standing despite a paucity of research supporting its clinical utility in dysphagia diagnostics. The purpose of this study was to investigate whether components of an oral mechanism examination, i.e., binary judgments (complete/incomplete) of labial closure, lingual range of motion, and facial symmetry, were associated with increased odds of aspiration as confirmed by subsequent instrumental testing. Study design was a single-group consecutively referred case series with a single judge. A total of 4,102 consecutive inpatients from a large, urban, tertiary-care teaching hospital were accrued, with 3,919 meeting the inclusion criterion of adequate cognitive ability to participate in an oral mechanism examination followed immediately by a fiberoptic endoscopic evaluation of swallowing. Stepwise multiple logistic regression analysis indicated that participants with incomplete lingual range of motion had an odds of aspiration that was 2.72 times the odds of aspiration of those with complete lingual range of motion (95 % confidence interval [CI] = 1.96–3.79, $p < 0.0001$), and incomplete lingual range of motion was an independent risk factor for aspiration regardless of labial closure and facial symmetry. Participants with incomplete facial symmetry had an odds of aspiration that was 0.76 times the odds of aspiration of those with complete facial symmetry (95% CI = 0.61–0.95, $p = 0.017$). Isolated incomplete labial closure did not affect the odds of aspiration ($p > 0.05$). New and clinically relevant information was found for lingual range of motion and facial symmetry, i.e., when incomplete, the clinician should be alerted to potential increased odds of aspiration during subsequent instrumental dysphagia testing.

Keywords Deglutition · Deglutition disorders · Aspiration · Oral mechanism examination

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Introduction

Use of an oral mechanism examination is ubiquitous and long-standing in dysphagia diagnostics despite a paucity of research regarding its clinical utility. Specifically, there are scant publications in support of the premise that results of an oral mechanism examination are useful specific to subsequent instrumentally confirmed aspiration events. A call for research to address the importance of oral motor abilities as a component of comprehensive dysphagia assessment was made in 1999 [1], but very little subsequent research on adverse events, e.g., aspiration, has been published based upon results of an oral mechanism examination.

To date, all research that included an oral mechanism examination during clinical dysphagia screening to determine potential aspiration risk used confirmatory videofluoroscopic testing. Logemann et al. [2] included facial droop in the

screening procedure but made no mention of labial closure or lingual mobility. McCullough [3–5] included tongue (side to side) and lip (pucker/retract) movements during clinical assessment but did not include facial symmetry.

It would be of interest to determine how information obtained from an oral mechanism examination contributes to the dysphagia specialist's knowledge of odds of aspiration prior to instrumental evaluation. The purpose of this study was to investigate if components of an oral mechanism examination, i.e., binary (complete/incomplete) judgments of labial closure, lingual range of motion, and facial symmetry, were associated with increased odds of aspiration as confirmed by subsequent instrumental testing.

Methods

Subjects

This study was approved by the Human Investigation Committee, Yale University School of Medicine. In a prospective manner, 4,102 consecutive inpatients referred between January 1, 2000 and December 31, 2007 to speech-language pathology for formal dysphagia testing by their attending physician, physician assistant, or advanced-practice nurse practitioner participated. Inclusion criterion was adequate cognitive ability [6] to participate in an oral mechanism examination. A total of 3,919 participants who met the study criterion first received an oral mechanism examination followed immediately by a fiberoptic endoscopic evaluation of swallowing (FEES). Table 1 gives participant demographics and Table 2 gives participant diagnostic categories at the time of hospital admission.

Procedures

The study design was a single-group consecutively referred case series with a single judge.

Oral Mechanism Examination

All participants first had an oral mechanism examination to determine if labial closure, lingual range of motion, and facial

Table 1 Participant demographics

Gender[a]	
Females	$N = 1,780$ (43.5 %)
Males	$N = 2,314$ (56.5 %)
Age[b]	
Females	$X = 70.30$ years (range $= 2.0$–105.0)
Males	$X = 66.27$ years (range $= 2.2$–105.0)

[a] Data are missing for 8 (0.2 %) participants

[b] Data are missing for 20 (0.5 %) participants

Table 2 Diagnostic categories at time of admission

Diagnostic category	Participants[a]
Cancer	168
Cardiothoracic surgery	220
Dementia	127
Esophageal surgery	78
Head and neck surgery	172
Medical	1,214
Neurological (traumatic brain injury/other)	497
Neurosurgery	317
Parkinson's disease	30
Pulmonary	642
Stroke (left hemisphere)	302
Stroke (right hemisphere)	262
Stroke (brainstem)	54

[a] Missing data for 183 (4.5 %) participants due to inadequate cognitive ability to participate in the oral mechanism examination

symmetry were either complete or incomplete. The operational definitions were as follows: Labial closure was the ability to close the lips completely with no observable gaps. Lingual range of motion was the ability to protrude the tongue anteriorly beyond the lips and lateralize to the right and left labial commissures. Facial symmetry was the ability to smile and pucker symmetrically. Instructions were given verbally with visual demonstration as necessary.

Fiberoptic Endoscopic Evaluation of Swallowing (FEES)

The standard FEES protocol was then followed with slight modifications [7, 8]. Briefly, each naris was examined visually and the scope passed through the most patent naris without administration of a topical anesthetic or vasoconstrictor to the nasal mucosa, thereby eliminating any potential adverse anesthetic reaction and assuring the endoscopist of a safe physiologic examination [9]. The base of tongue, pharynx, and larynx were viewed, and swallowing was evaluated directly with six food boluses of approximately 5–10 cc each. Patients were encouraged to feed themselves, with assistance as needed, i.e., liquid with a straw or cup and puree with a spoon. All patients were allowed to swallow spontaneously, i.e., without a verbal command to swallow [10]. FEES equipment consisted of a flexible fiberoptic rhinolaryngoscope (model VNL-117OK; KayPentax, Lincoln Park, NJ), light source (KayPentax model EPK-1000), and a digital swallow workstation (KayPentax model 7200).

The first food challenge consisted of three boluses of puree consistency (yellow pudding) followed by three thin liquid boluses (white, fat-free, skim milk); the colors of these boluses have excellent contrast with pharyngeal and

laryngeal mucosa [11]. Aspiration was defined as entry of material into the airway below the level of the true vocal folds [12]. Identification of aspiration on a single trial of either liquid or puree consistency confirmed presence of aspiration.

Statistical Analysis

The three components of the oral mechanism examination, i.e., labial closure, lingual range of motion, and facial symmetry, were related to aspiration using Fisher's exact test for univariate analysis and multiple logistic regression analysis for the multivariate analysis. Odds ratio was defined as the odds of aspiration when a component was incomplete divided by the odds of aspiration when the component was complete.

Results

Reliability Testing

All oral mechanism and FEES examinations were judged live. A 100 % nonblinded agreement between the endoscopist (SBL) and assisting health-care professional, e.g., physician, physician assistant, speech-language pathologist, registered nurse, or respiratory therapist, was required to confirm both oral mechanism functioning and tracheal aspiration. Confirmatory interrater reliability for the oral mechanism examination was performed with 25 additional participants. Experienced speech-language pathologists as well as naïve physician assistants, registered nurses, physical therapists, and occupational therapists participated. There were a total of 228 blinded and independent ratings, i.e., 76 each for lingual range of motion, labial closure, and facial symmetry. Interrater agreement was 100% for binary (complete/incomplete) judgments of labial closure, lingual range of motion, and facial symmetry.

Confirmatory intra- and interrater agreement of FEES findings was performed with 128 additional participants. Two speech-language pathologists and one otolaryngologist experienced in interpreting FEES results independently and blindly reviewed the swallows on a digital swallowing workstation. Using real-time analysis with repeat viewing as needed, both intra- and interrater agreement ratings were 100 % for tracheal aspiration on at least one liquid or puree swallow during FEES.

Labial Closure, Lingual Range of Motion, Facial Symmetry, and Aspiration

Of the 3,919 participants, 172 (4.4 %) exhibited incomplete labial closure, 179 (4.6 %) exhibited incomplete

lingual range of motion, and 638 (16.3 %) exhibited incomplete facial symmetry. A total of 900 (23.0 %) participants aspirated during FEES testing. Table 3 gives univariate analyses of incidences of aspiration associated with complete/incomplete judgments of labial closure, lingual range of motion, and facial symmetry. Only incomplete lingual range of motion was significantly associated with an increased odds ratio for aspiration, i.e., 72/179 (40.2 %) versus 823/3,740 (22.1 %), odds ratio = 2.37, $p < 0.0001$.

A stepwise multiple logistic regression analysis was conducted to determine odds of aspiration for the 3,919 participants based on a binary (complete/incomplete) judgment of labial closure, lingual range of motion, and facial symmetry. Significant variables in the resulting model were lingual range of motion and facial symmetry. Odds ratios indicated that participants with incomplete lingual range of motion had an odds of aspiration that was 2.72 times the odds of aspiration in those with complete lingual range of motion (95 % confidence interval [CI] = 1.96–3.79, $p < 0.0001$). Participants with incomplete facial symmetry had an odds of aspiration that was 0.76 times the odds of aspiration in those with complete facial symmetry (95 % CI = 0.61–0.95, $p = 0.017$). Isolated incomplete labial closure did not affect the odds of aspiration ($p > 0.05$).

Discussion

It was found that when either lingual range of motion or facial symmetry is judged incomplete, the clinician should be alerted to the potential for increased odds of aspiration during subsequent instrumental dysphagia testing.

Table 3 Univariate analyses of incidences of aspiration associated with complete/incomplete labial closure, lingual range of motion, and facial symmetry

	Incidence of aspiration (%)
Labial closure	
Complete	851/3,747 (22.7)
Incomplete	49/172 (28.5)
Odds ratio = 1.36 (95 % CI = 0.97–1.90) ($p = 0.08$)	
Lingual range of motion	
Complete	823/3,740 (22.1)
Incomplete	72/179 (40.2)
Odds ratio = 2.37 (95 % CI = 0.76–1.14) ($p < 0.0001$)	
Facial symmetry	
Complete	760/3,281 (23.2)
Incomplete	140/638 (21.9)
Odds ratio = 0.93 (95 % CI = 0.76–1.14) ($p = 0.50$)	

Furthermore, the contribution of facial symmetry in the regression model is interesting. Univariate analysis found only incomplete lingual range of motion to be associated with odds of aspiration (Table 3). However, the stepwise logistic regression model found a robust 2.72 increase in odds of aspiration associated with incomplete lingual range of motion but a weak 0.76 increased odds of aspiration associated with incomplete facial symmetry. Therefore, the dysphagia specialist may choose to place increased clinical importance in regard to odds of aspiration on incomplete lingual range of motion versus incomplete facial symmetry.

Importantly, incomplete lingual range of motion was an independent risk factor for aspiration regardless of labial closure and facial symmetry. Incomplete facial symmetry was a risk factor for aspiration only if both lingual range of motion and labial closure were incomplete. Incomplete labial closure by itself did not affect the odds of aspiration.

Although labial closure was not associated with increased odds of aspiration, it is still a clinically relevant component of the oral mechanism examination and should continue to be evaluated in patients with suspected dysphagia. Complete labial closure prevents bolus loss and drooling and is crucial for a successful oral phase of swallowing. Referral to neurology or otolaryngology to determine if a lesion or tumor, respectively, is the etiology of incomplete labial closure is appropriate. Once an etiology is determined, e.g., neurological (apraxia or paresis) or surgical (soft tissue insult or nerve resection), appropriate rehabilitation can be instituted.

It is advantageous to perform a baseline oral mechanism examination before surgery, irradiation, or chemotherapy [13]. This information is useful when counseling the patient regarding any possible new post-treatment changes in feeding skills, e.g., difficulty taking a bolus off a spoon or drinking with a cup/straw, and swallow function, e.g., poor oral bolus control including drooling and stasis as well as mastication changes with specific food textures.

An oral mechanism examination is also a useful method for tracking longitudinal changes in swallow function. Changes in the oral mechanism examination may trigger a referral for an instrumental swallowing evaluation, i.e., endoscopic or videofluoroscopic, with the goal of enhancing patient safety, efficiency, and quality of life.

Study Strengths, Limitations, and Future Research

This study comprised a large sample size accrued in a prospective and consecutive manner, spanned the age range, and included a wide variety of diagnoses representative of the inpatient population of a large, urban, tertiary-care, teaching hospital. The limitations of this study were that there was no analysis of bolus flow characteristics and that a referral-based population sample with a single nonblinded judge were used. The latter is mitigated, however, by strong post hoc confirmatory intra- and interrater reliability for both oral mechanism judgments and identification of tracheal aspiration. Future research should investigate the use of an oral mechanism evaluation to track longitudinal changes pre- and postintervention and to determine if earlier, rather than later, treatment intervention improves swallow function. It would also be of interest to perform a videofluoroscopic evaluation of swallowing to investigate whether incomplete lingual range of motion observed during oral mechanism testing corresponds to difficulties with bolus clearance, bolus propulsion, and bolus containment.

Conclusions

Two components of an oral mechanism examination, i.e., incomplete lingual range of motion and incomplete facial symmetry, increased the odds of aspiration as observed during subsequent instrumental dysphagia testing. Incomplete labial closure, although not associated with increased odds of aspiration, remains an important component to evaluate. An oral mechanism examination can be used to compare pre- and post-therapeutic interventions and outcomes, to document longitudinal changes in oral motor and swallowing functions, and to help determine where and when to focus therapy to improve dysphagia.

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