Swallowing dysfunction in patients with head-and-neck cancers

1. Introduction: Swallowing biomechanics

Swallowing is divided into four phases:

(1) Preparatory phase: the central anterior two-thirds of the tongue

(2) Oral phase, the tongue elevates and contacts the palate while the nasopharynx closes by elevation of the soft palate against the posterior pharyngeal wall.

(3) Pharyngeal phase begins as the bolus passes the tonsillar pillars and the tongue base contacts the posterior pharyngeal wall. Elevation of larynx & relaxation of the cricopharyngeus muscle

(4) Esophageal phase begins as the wave of pharyngeal peristalsis passes through the upper esophageal sphincter

(5) Swallowing reflex trigger: elevation and retraction of soft palate, elevate and closure of the larynx, pharyngeal peristalsis, and cricopharyngeal relaxat

(6) Saliva: moistening, control oral microbial flora, buffer

<table>
<thead>
<tr>
<th>Timing</th>
<th>Cause of Aspiration</th>
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<tbody>
<tr>
<td>Prior to swallowing</td>
<td>Failure of the glossopalatal seal with premature leakage from the mouth entry into the open larynx</td>
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<tr>
<td>During swallowing</td>
<td>Poor laryngeal elevation, poor laryngeal closure, incomplete epiglottic tilt</td>
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<tr>
<td>After swallowing</td>
<td>Overflow of retained bolus, late emptying of a pouch or diverticulum, regurgitation from the esophagus, GER</td>
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</table>

2. Methods for measuring swallow function

(1) **Manometry**: provides important, but limited, information in swallow physiology
(2) **Videofluorography (VFG)**

Videofluoroscopic swallowing study with barium meal in thin 5mL, thick 5mL, paste 5mL in lateral view, and thin 5mL in AP view shows:

1. **Oral phase:**
   - oral drooling, bolus holing, oral stasis, oral mucosal coating, premature oral leakage, piecemeal swallowing, tongue-palate contact

2. **Swallowing times:** thin, thick, paste
   - Oral transit time (normal < 2s):
   - Pharyngeal transit time (normal < 1s):
   - Swallowing trigger (normal < 1s):

3. **Pharyngeal phase:**
   - vallecular stasis, pyriform sinus stasis, velar elevation, hyoid bone elevation, epiglottic movement, pharyngeal contraction, pharyngeal mucosal coating, pharyngeal-oral reflux, pharyngeal-nasal reflux, normal retropharyngeal soft tissue, symmetric bolus pass into esophagus
   - Laryngeal penetration, Aspiration

4. **Oropharyngeal swallow efficiency (OPSE):** approximate percent of the bolus swallowed into the esophagus divided by oropharyngeal transit time

   1. **Oral transit time (OTT):** The time it takes the bolus to move through the oral cavity, measured from the first backward movement of the bolus until the head of the bolus passes the point where the ramus of the mandible crosses the tongue base. Normal OTTs are < 1 second.

   2. **Pharyngeal transit time (PTT):** The time required for the bolus to move through the pharynx, measured from the time the head of the bolus passes the ramus of the mandible until the tail of the bolus leaves the cricopharyngeal region. Normal pharyngeal transit times are < 1 second.

   3. **Pharyngeal delay time:** The time required to trigger the pharyngeal swallow, measured from the time the head of the bolus passes the ramus of the mandible until the onset of soft palate elevation. Normal swallows do not have any delay time.

   4. **Pharyngeal response time:** The time required to clear the pharynx, measured from the time of the onset of soft palate elevation until the tail of the bolus leaves the cricopharyngeal region. Normal pharyngeal response times are < 1 second.

   5. **Duration of laryngeal closure:** The length of time the laryngeal entrance between the arytenoid and base of epiglottis is closed during the swallow. Normal laryngeal closure durations are approximately one-half second.

   6. **Duration of cricopharyngeal opening:** The length of time the cricopharyngeal region is open during the swallow. Normal cricopharyngeal opening durations are approximately one-half second.
(3) Fiberoptic endoscopic examination of swallowing (FEES)

Pudding and liquid dye

1. Aspiration before swallow

Oral-phase problem, delayed motor response and/or decreased sensory acuity of the pharynx, delay in swallowing initiation

2. Aspiration during swallow

Delayed arygeal closure mechanisms, breakdown of one or more of the laryngeal closure mechanisms

3. Aspiration after swallow

Unilateral or bilateral, decreased or uncoordinated pharyngeal contractions

<table>
<thead>
<tr>
<th>Items for comparison</th>
<th>Exam recommended</th>
<th>Remarks</th>
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</thead>
<tbody>
<tr>
<td>Evaluation of swallowing safety</td>
<td>FEES</td>
<td>FEES: more sensitive</td>
</tr>
<tr>
<td>Laryngopharyngeal anatomy</td>
<td>FEES</td>
<td>FEES: three-dimensional panoramic view</td>
</tr>
<tr>
<td>Dynamic physiology</td>
<td>VF / FEES</td>
<td>Further comparative study is necessary</td>
</tr>
<tr>
<td>Comprehensive study</td>
<td>VF</td>
<td>VF: all three phases and interphase relationship</td>
</tr>
<tr>
<td>Accessibility</td>
<td>FEES</td>
<td>FEES: easily transportable and instantly available</td>
</tr>
<tr>
<td>Efficiency</td>
<td>FEES</td>
<td>FEES: less time consuming and less staff needed</td>
</tr>
<tr>
<td>Noninvasive</td>
<td>FEES</td>
<td>27 mm/min for thyroid in lateral VF projection (13)</td>
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<tr>
<td>Biofeedback training</td>
<td>FEES</td>
<td>FEES: real-time recording and repeatable</td>
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3. Swallowing dysfunction with head-and-neck cancers

- **Irradiated NPC patients**
  - Multiple dysfunctions: aspirate after the act of swallowing: 77.4%; tongue atrophy: 54.8%, vocal cord palsy: 29%. Dry mouth: 45.2%, Velopharyngeal incompetence: 58%, Premature leakage: 41.9%. Delay or absence of swallow reflex: 87.1%, Poor pharyngeal constriction: 80.6%, Pharyngeal residue retention: 83.9%, Penetration or aspiration: 93.5%, and silent aspiration (41.9%)
  - Abnormality of pharyngeal constriction and/or aberrant upper esophageal sphincter function played the major role in the postswallow aspiration of these
- **Oral/Oropharyngeal cancer/Laryngeal cancer**
  - Lip: 3/4 lower lip or 1/2 lower lip with commissure: drooling
  - Oral or oropharyngeal cancer: 144 cases OPSE negatively correlated with total volume resected, total percent oral tongue resected, total percent tongue base
resected. Percent oral reside was positively correlated. PTT was positively correlated with percent tongue base resected. PRT was positively correlated with soft palate resected.

- Primary closure, or skin graft, or graft reconstruction
- Relation between surgical procedure and cause of aspiration

<table>
<thead>
<tr>
<th>Type of surgery procedure</th>
<th>Before swallowing</th>
<th>During</th>
<th>After swallowing</th>
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<tbody>
<tr>
<td></td>
<td>total</td>
<td>Delay</td>
<td>Reduced</td>
</tr>
<tr>
<td></td>
<td>procedure</td>
<td>reflex</td>
<td>tongue control</td>
</tr>
<tr>
<td>Anterior composite</td>
<td>4</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Lateral composite</td>
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<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Total glossectomy</td>
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<td>1</td>
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</tr>
<tr>
<td>Pharyngeal resection</td>
<td>1</td>
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<tr>
<td>Hemilaryngectomy</td>
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<tr>
<td>Extended hemilaryngectomy</td>
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<td>1</td>
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<tr>
<td>Supraglottic laryngectomy</td>
<td>9</td>
<td>2</td>
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<tr>
<td>Extended supraglottic</td>
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<td>2</td>
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<tr>
<td>laryngectomy</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>total</td>
<td>30</td>
<td>5</td>
<td>7</td>
</tr>
</tbody>
</table>

4. Strategies to decrease swallowing disorders

Preventative strategies
- RT beam modulation
- Rehabilitation strategies
- Range of motion and resistance exercise
- Compensatory treatment procedures
  - introducing postures and adjusting bolus volume and consistency
  - intraoral prosthetics
- Therapy exercises
  - Exercises to increase tongue strength
  - Swallow maneuvers
    - Super-supraglottic swallow, which involves closing the airway entrance
before and during the swallow

✧ Mendelsohn maneuver, which prolongs and increases the diameter of the opening of the upper esophageal sphincter during the swallow

✧ NG tube insertion or gastrostomy

✧ Total laryngectomy

5. General conclusion

Clinicians must learn to anticipate and identify the various deficits of swallowing functions in patients. Swallowing studies are necessary to better define the pathophysiology of swallowing disorders clinically and can develop better preventative and rehabilitative measures which will improve patients' quality of life and also be cost effective.

Reference


