Trachs and Dysphagia with SCI patients
Considerations for treatment and Review of the literature

Overview

• Respiration and swallowing with SCI patients
• Tracheostomy tubes (trachs) and mechanical ventilator basics (vents)
• Common notions about swallowing treatment with trachs/vents
  – What does the research say?
• Considerations for evaluation and treatment

Innervation for swallowing and respiration

Cranial nerves-supply muscles for swallowing

Spinal nerves-supply muscles for respiration

Nerve Roots
Cranial Nerves for swallowing

Cranial nerves emerge from different levels of the brainstem (midbrain, pons, medulla oblongata).

The cranial nerves for swallowing:
CN V Trigeminal- Pons
CN VII Facial- Pons
CN IX Glossopharyngeal- Medulla
CN X Vagus- Medulla
CN XII Hypoglossal- Medulla

Most of muscles for swallowing are innervated by cranial nerves.

Cranial Nerves and swallowing

Trigeminal (CN V)
Sensory:
- Position of bolus in mouth
- Pocketing
Motor:
- Cheating
- Assists with hyoid elevation
- Velar elevation

Facial Nerve (CN VII)
Sensory:
- Sensation of tongue and taste
Motor:
- Tone and movement of cheeks
- Lip closure
- Assists with hyoid elevation

Glossopharyngeal (CN IX)
Sensory:
- Senses arrival of bolus at palate
- Taste
- Decreased gag reflex
Motor:
- Pharyngeal constriction and shortening

Hypoglossal (CN XII)
Motor only:
- Power source for muscles of tongue
- Hyoid-thyroid approximation
- Hyoid protraction

Vagus nerve CN X

Motor:
- VP closure
- TBR
- VF approximation
- Middle and inferior pharyngeal constriction
- UES relaxation
- Peristalsis in esophagus
Sensory:
- Taste in oropharynx
- Sensation of residue in pharynx, larynx, esophagus

Branches:
- Pharyngeal branch
- Superior laryngeal nerve
  - External branch innervates cricothyroid and supraster nal pharyngeal constrictors. Responsible for pitch adjustments.
  - Internal branch- sensory to base of tongue and epiglottis pass through cricothyroid
- Recurrent laryngeal nerve innervates muscles of larynx (except cricothyroid)
Impact of injury level

<table>
<thead>
<tr>
<th>Respiratory Muscles</th>
<th>Function</th>
<th>Innervation</th>
<th>Impact</th>
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</thead>
<tbody>
<tr>
<td>Diaphragm</td>
<td>Primary muscle of respiration</td>
<td>C3-C5 (phrenic nerve origin)</td>
<td>Injury above C5 may require ventilation</td>
</tr>
<tr>
<td>Intercostals</td>
<td>Coughing/deep breathing</td>
<td>T5-T12</td>
<td>Injury above T8 may reduce ability to cough/deep breath</td>
</tr>
<tr>
<td>Abdominals</td>
<td>Assist with cough</td>
<td>T7-L1</td>
<td>Injury above T12 may reduce strength of cough</td>
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</tbody>
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SCI impact on respiration and swallowing

- Impact on swallowing
  - Very high SCI that injures CNs
  - Vagus injury from trauma
  - Weakness from disuse during recovery

- Impact on respiration
  - Inhalation/exhalation or airway protection
  - Depends on level of injury
  - May be long-term
Purpose of vents/trachs

- Failure of normal airway function necessitates need for artificial airway
- A tracheostomy tube is a long term option
- Depending on level of injury, SCI patient may need trach to:
  - Move air into and out of lungs
    - Maintains airway patency (open airway)
    - Assist in removal of secretions
    - Weak cough
    - Allow mechanical ventilation

Normal swallowing

- Very complex system
- Need ROM, strength, timing, speed, sensation
- Both mechanical and pressure driven

Mechanical airway protection

- Larynx elevates out of bolus path
- Epiglottis inverts
- Vocal folds adduct
Pressure driven

• Swallow is series of chambers and valves
• Combination of positive and negative pressure propel bolus through the system

Impact of trach tube on swallowing

• Decreased ability to cough to protect airway
• Impact sensation
  – Decreased awareness of aspiration and secretions
• Impact ROM, speed/timing
  – Tethering of larynx (?)
• Impact pressure system
  – Air escapes from trach, subglottic pressure can’t be generated (?)

Trach weaning Hierarchy

• Trach with cuff attaches to ventilator
• Trach with cuff, no vent
• Cuffless trach/fenestration
• Speaking valve
• Capping
Trach with cuff up

- Cuff assures that air moves in/out of trach
- May be attached to a ventilator
- Protects somewhat from secretions above — “Controlled aspiration”

Open trach with cuff down

- Most of air in/out of trach
- May be able to speak around trach
- May be fenestrated which can allow more air through nose and mouth

One way speaking valve with cuff down

- Passy-Muir “closed position valve”
- Normally fully sealed, open only during inhalation
- Inhale through trach, exhale through nose/mouth
- Allows speech and coughing
Capped with cuffless trach

• All inhalation/ exhalation through nose/mouth
• May do part of day/night

Common notions about trachs/vents and swallowing

“Must wait until off vent to assess swallowing”

• It’s not the ventilator….it’s the patient’s medical status
• Vent is merely a symptom of medical condition
• Many patients can swallow on vent- don’t delay swallow eval because of vent
• SCI patients may be on vent long term
“Removing trach improves swallowing”

- Tethering of larynx (?)
- Some patients may have improved swallowing after removal of trach
- But the research shows this is less of an absolute than we may think

- Let’s look at some of the research...

Trach impact on swallowing

- Donzelli 2005: *Effects of the removal of the tracheotomy tube on swallowing during the fiberoptic endoscopic exam of the swallow (FEES).*
  
  - 37 patients; assessed with trach occluded, reassessed with trach removed
  
  - Findings:
    - 35/37 patients’ aspiration status stayed the same
    - 29/37 penetration status the same
  
  - Key point: Tethering from trach may not always be an issue

Tethering of the larynx?

  
  - 7 normal adults: trach with cuff up, trach capped, trach out
  
  - Investigated movement of hyoid bone and larynx during normal swallowing
  
  - Findings: No statistically significant differences in hyoid or laryngeal movement with various trach conditions
  
  - Of note: Would trach have more impact on patients with weak swallow? This may explain inconsistencies
  
  - Key point: Trach alone may not tether larynx
Trach impact on swallowing

  - 20 patients: eval before trach, with trach, and after decannulation
  - Findings: 95% of subjects exhibited same aspiration status before/after tracheotomy
  - Of Note: Looked at presence/absence of aspiration only. Changes may have been detected if looked at *quantity* of aspiration.
  - Key point: Decannulation may not improve swallowing

Trach impact on swallowing

- Conclusions:
  - No consistent evidence that the trach tethers the larynx
  - Decannulation doesn’t always improve swallowing

Cuff inflation notions...

1. “Cuff inflation makes swallowing worse”
2. “Don’t eat/drink while cuff inflated”
3. “Cuff will protect a pt from aspiration”
4. “Can’t do swallowing treatment with cuff inflated”
1. “Cuff inflation makes swallowing worse”

- Retrospective of 623 patients with trachs, investigating trends with cuff inflated and cuff deflated. No patient was assessed in both conditions for comparison.
  - Findings: Cuff inflated: Statistically significant higher change in laryngeal elevation and silent aspiration
  - Speculated that inflated cuff blocks expiratory air flow resulting in decreased aspiration sensitivity
  - Key point: Cuff deflation may impact some patient’s ability to detect aspiration

2. “Cuff inflation makes swallowing worse”

  - 14 patients: assessed penetration/aspiration, hyolaryngeal excursion, residue with cuff inflated, cuff deflated, one-way valve
  - Findings re: cuff: Pen/asp scores not impacted by cuff status; no changes in swallowing physiology in any condition
  - Key Point: Impact of cuff status alone is inconsistent and may not change swallowing much

3. “Don’t do PO intake while cuff inflated”

- Cuff deflation is not a guarantee of improved swallowing
- Should assess each patient in what ever condition they will be doing PO intake

3. “Cuff will protect from aspiration”

- Secretions sitting on cuff are already aspirated
- Cuff is not water-tight
- May help with “controlled aspiration”
4. “Can’t do swallowing treatment with cuff inflated”

- No evidence of need to avoid swallowing with cuff inflation
- Concern about over-inflated cuff
- Need to monitor pressure of cuff with mercury manometer (pressure less than 25 mm Hg)

Cuff conclusions

- Cuff status may or may not change swallowing function with each patient
- Best to evaluate and treat the patient with the cuff in the position it is most likely to be in during PO intake
- Decisions about PO intake, swallowing tx, and aspiration safety should be made with regards to the patient’s swallowing function, not cuff status

“A speaking valve/cap will improve swallowing”

- Restoring subglottic air pressure # swallowing always improved
- Impact of subglottic air pressure suspected to be multi-factorial
  - Would explain inconsistencies in impact of occlusion on swallowing
  - Subglottic mechanoreceptors
    - Sensitive to changes in air pressure
    - Afferent input from respiration may input to swallowing central pattern generator
  - Respiratory characteristics during swallow can change with speaking valve/cap
    - Higher incidents of aspiration at different points in inhale/exhale
    - Lung volumes vary
    - Higher lung volumes= higher subglottic air pressure

Subglottic Air Pressure

• Based on the Gross study, valve/cap may help with several aspects of respiration and swallowing:
  – normalizing subglottic pressure
  – swallowing/breathing coordination
  – pulmonary function
  – lung forces

• Depending on these factors with each patient, impact of occlusion will be different

• Let’s look at the literature....

Speaking valves and swallowing


• 11 patients with trach and known aspiration; MBS with and without PMV
• Findings: All 11 had “decreased” aspiration.
• Of note: no objective measurements of aspiration, not blinded, some patients did other compensations with valve (head turn)
• Key Point: PMV can change swallowing function (but how and how much?)

Speaking valves and swallowing


• 15 subjects assessed via MBS with thin liquids with and without PMV.
• Findings: 7 subjects aspirated on one or more presentations, 8 did not aspirate at all in either condition.
• PMV reduced, but did not eliminate occurrences of aspiration.
• Key Point: Benefit of PMV should be assessed on a case by case basis
Speaking valves and swallowing

- 4 adults-compare depth of penetration, bolus speed, duration of swallow with open and closed trachs.
- Findings: Pharyngeal swallow significantly different in open/closed conditions.
- Of note: 3 patients with greatest difference wore PMV all day-suspect that it is the length of time the subglottic receptors have lack of stimulation that may impact swallowing.
- Key Point: Impact of valve on swallowing may include many factors

Speaking valves and swallowing

- 14 patients: assessed penetration/aspiration, hyolaryngeal excursion, residue with cuff inflated, cuff deflated, one-way valve
- Findings: Pen/asp score improved with valve for some patients with thin liquid trials only
- Patients that had decreased aspiration had increased residue
- No changes in swallowing physiology in any condition
- Key point: Impact of PMV is likely positive but may vary

Conclusions about speaking valves

- Likely that PMV can significantly change swallowing to some degree
- Reasons for why the valve may change swallowing are still being discovered
- Impact of PMV on swallowing should be assessed on case by case basis
“Can’t use modalities with trach”

- Modalities
  - Treatment tools added to therapy
  - NMES, sEMG

- If using electrodes on supra/infrahyoids, path of current is away from trach

Bottom line....
So now what do I do with my patients?

Evaluation of swallowing with trachs/vents

- Don’t wait for change in trach/vent status to evaluate patients’ swallowing

- Diagnostic treatment to monitor may be appropriate

- Earlier intervention is ideal
When is an eval not appropriate?

- Medically compromised
  - Infection/fever
  - Impact of medications
  - Vital signs (heart rate, breath rate, SpO2, lab values)

- Status changing often- will recommendations from swallow eval still be appropriate if level changes?

- Poor level of alertness/insufficient cognition for PO trials

- Ask “If pt “passes” swallow eval, would I do treatment or give PO?”

Modified Evans Blue Dye Test

- Blue dye given orally, monitor for blue in secretions
  - If blue noted:
    - Don’t know what caused aspiration or quantity of aspiration
    - Don’t have information needed for planning swallowing therapy
    - If multiple consistencies given, don’t know which aspirated
  - If no blue noted:
    - Not 100% reliable that aspiration didn’t occur

Blue dye test

- May be useful for
  - Screening for aspiration of secretions
  - Screening for ability to tolerate cuff deflation with regards to aspiration of secretions
  - If “negative”, need to do additional testing

- Less useful for
  - Assessing ability to swallow different consistencies
  - Determining ability to start PO
  - Gathering info for treatment planning
Instrumental Evaluations

- Modified barium swallow studies (MBS)
  - Still a great way to assess swallowing and plan tx based on dysfunctions
  - Can be tricky to get patients on vent to radiology

- Fiberoptic Endoscopic Evaluation of Swallowing (FEES)
  - Can be more challenging to assess all aspects of swallowing for tx planning
  - Much easier for vent patients than MBS
  - Can be nice addition to blue dye to determine ability to manage secretions

Treatment

Exercise is key to improving swallowing

The longer NPO, the more possibility for disuse atrophy

Exercise physiology principles for swallowing treatment....

Exercise intensity

- Related to the muscular effort used during exercise
- Many variables influence exercise intensity:
  - Load (weight), training pace (execution speed), rest time (or lack of), number of sets, etc.
- Must be at an intensity to make muscle have a need to get stronger
- Ask “am I pushing the muscles enough so they will need to get stronger?”
Specificity of exercise

- Relates to how closely the exercise movement mirrors the desired functional outcome in terms of form and function
- Rule of thumb: whenever possible, use the desired function as the exercise
- Best exercise for swallowing is swallowing

In conclusion....

Swallowing eval and treatment can be appropriate for patients with trachs and vents.

Impact of trach on swallowing function is multifactorial, so can’t make assumptions about swallowing with changes in trach status.

Evaluation, treatment, and recommendations should be individualized and reassessed at different points of trach weaning process.

Thank you!

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