Resistance Straws and the Effortful Swallow Maneuver

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The current study explored the physiology of effortful swallows preceded by sucks from high resistance straws.
Effortful Swallow Maneuver

- Compensatory technique for dysphagia symptoms (reduced pharyngeal constriction, pharyngeal and vallecular residue, and reduced bolus control) (Dejaeger, Pelemans, Ponette, & Joosten, 1997; Hiss & Huckabee, 2005; Hind, Nicosia, Roecker, Carnes, & Robbins, 2001).
Effortful Swallow Maneuver

- Uses increased neuromuscular drive as an indirect way of achieving overload (Logemann, 1998)
Submental Surface Electromyography

- sEMG: used for measurement and evaluation of muscle activity during swallowing (Crary & Baldwin, 1997)
- sEMG shows that the effortful swallow has increased amplitude of activation in submental musculature. This suggests that submental muscles are important for tasks that require increased effort and volitional control over the swallow (Wheeler et al., 2007).
- sEMG measurement is nonspecific to floor of mouth activity and includes intrinsic lingual activity (Huckabee & Steele, 2006)
Lingual Swallowing Pressure

- Lingua-palatal swallowing pressures are one index of swallowing intensity (Huckabee & Steele, 2006;).

- Swallowing pressures increase during the effortful swallow (Huckabee & Steele, 2006 and any other sources).
Resistance Straws

- The Therasip Swallow Trainer™ employs a series of four straws that offer increasing resistance (Smead, 2010).

- An ‘effortful suck’ is necessary to draw liquid through the various microscopic straw diameters.
Hypothesis

- The high effort required to draw liquid from the straws will carry over to the effortful swallows executed following each sip.
Participants

- N = 41 participants
  - 36 females (age range 18 to 59) with a mean age of 22.3 years
  - 5 males (age range 22 to 50) with a mean age of 34 years.

- No reported history of speech or swallowing problems or of diseases that impact muscles used for speaking or eating
Instrumentation

- **Iowa Oral Performance Instrument** (lingual swallow pressure measures)
- **Kay Elemetrics Digital Swallowing Workstation** (submental electromyography – muscle activity measures)
Bolus Swallows

- Non-effortful (Trials 1 & 2): “Take one sip as normally as possible and then swallow as normally as possible.”

- Effortful (Trial 3): “Take one sip, suck as hard as you can, and swallow as hard as you can.”
Dry Swallows

- Non-effortful (Trials 1 & 2)
- Effortful (Trial 3)
### Straw Characteristics

<table>
<thead>
<tr>
<th>Straw Color</th>
<th>Diameter (in)</th>
<th>Volume (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gray</td>
<td>08 x 10.25 in</td>
<td>11.63 ml (7.01)</td>
</tr>
<tr>
<td>Blue</td>
<td>05 x 10.25 in</td>
<td>6.38 ml (4.00)</td>
</tr>
<tr>
<td>Orange</td>
<td>03 x 10.25 in</td>
<td>3.14 ml (2.15)</td>
</tr>
<tr>
<td>Red</td>
<td>025 x 10.25 in</td>
<td>2.11 ml (1.93)</td>
</tr>
</tbody>
</table>

Table 1: Straw characteristics (Hietpas, et al., 2009)
TheraSIP™ Resistance Straws
TheraSIP™ Resistance Straws
TheraSIP™ Resistance Straws
Results

- **Orange straw** produced significantly higher muscle activity than the **red straw** \[t(79) = 2.625, p = .010\]

- **Blue straw** produced significantly higher lingual pressure than the **red straw** \[t(81) = 3.554, p = .001\]
Results

- All other straw comparisons were not significant.

- The interaction of straw and swallow condition was not significant for lingual pressure or muscle activity.
Non-effortful condition: Dry swallow elicited highest pressure and muscle activity

Effortful condition: Dry swallow elicited highest pressure and muscle activity

The effortful swallows produced 5-6kPa and 30µV greater than non-effortful swallows
### Mean peak lingual swallowing pressures in kilopascals

<table>
<thead>
<tr>
<th>Straw Condition</th>
<th>Mean (SD) Swallow Pressure (kPa)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Non-effortful</td>
</tr>
<tr>
<td>Dry</td>
<td>24.6 (9.7)</td>
</tr>
<tr>
<td>Gray</td>
<td>20.8 (9.5)</td>
</tr>
<tr>
<td>Blue</td>
<td>23.4 (9.5)</td>
</tr>
<tr>
<td>Orange</td>
<td>23.7 (10.0)</td>
</tr>
<tr>
<td>Red</td>
<td>20.1 (7.6)</td>
</tr>
</tbody>
</table>
Mean Peak Lingual Swallowing Pressures for Each Straw Condition

Straw Condition

Dry
Gray
Blue
Orange
Red

Mean Swallow Pressure (kPa)

Non-effortful (kPa)
Effortful (kPa)
Mean peak muscle activity in microvolts

<table>
<thead>
<tr>
<th>Swallowing Condition</th>
<th>Mean (SD) Peak Muscle Activity (µV)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Non-effortful</td>
</tr>
<tr>
<td>Dry</td>
<td>80.7 (28.4)</td>
</tr>
<tr>
<td>Gray</td>
<td>69.1 (25.6)</td>
</tr>
<tr>
<td>Blue</td>
<td>72.5 (25.3)</td>
</tr>
<tr>
<td>Orange</td>
<td>76.5 (27.6)</td>
</tr>
<tr>
<td>Red</td>
<td>69.2 (20.7)</td>
</tr>
</tbody>
</table>
Mean Peak Muscle Activity for Each Straw Condition

Graph showing the mean peak muscle activity (µV) for different straw conditions: Dry, Gray, Blue, Orange, and Red. The graph compares non-effortful (blue) and effortful (red) conditions.
Results suggest high resistance straws do not create a ‘ramping up’ of neuromuscular drive that overflows into harder effortful swallow.

Larger diameter straws had higher values than those with smaller diameters.
Discussion

- Dry effortful had higher muscle activity and swallow pressures than any straw bolus swallows, effortful and non-effortful
Clinical Implications

- These findings provide additional support for the benefits of the effortful swallow for patients with decreased swallowing pressures.

- Although immediate added benefits of high resistance straws were not observed, further research may identify particular training conditions under which resistance straws may be beneficial.
References


