Swallow with Chin Tuck Against Resistance (S-CTAR): New Task-Specific Swallowing Exercise for Training Submental Muscles

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ABSTRACT

Exercises that involve swallowing tasks follow many of the principles of neuroplasticity and represent a more efficient approach to swallowing rehabilitation as they are task-specific (Robbins et al., 2008). Chin Tuck Against Resistance (CTAR) is a non-swallowing exercise but it can be made into a task-specific swallowing exercise by incorporating a swallow with CTAR (S-CTAR). To test the impact of adding a swallow during the CTAR exercise, we compared the Surface electromyography (sEMG) activity of the submental muscles under 6 conditions: Resting state, normal swallow, Chin Tuck, Chin Tuck swallow, CTAR, and S-CTAR, (Swallow-CTAR) using a within-participants design. Maximum and mean sEMG values measured for S-CTAR swallow trials were significantly higher than the values measured for CTAR alone and for the other four conditions. CTAR swallow causes greater activation of the submental muscle group than CTAR alone suggesting the swallow component does enhance effectiveness.

INTRODUCTION

Dysphagia is present in over 20% of elderly patients at hospital discharge (Lee et al., 1999). Apart from reduced quality of life, there are serious health risks associated with dysphagia including lower respiratory tract infection, malnutrition, and even death, (e.g., Martin et al, 1994). The CTAR exercises, which incorporate both intensity and muscle-specificity, have been shown to have an impact on the suprahyoid muscles (Sze et al. 2016, Yoon et al. 2014) but this intervention lacks task-specificity. If greater gains are more likely when the training task and target behaviour are closely matched (Burkhead et al, 2007), then swallowing activity during the CTAR regime (S-CTAR) should enhance rehabilitation outcome as well as face validity. In a within-participants design, we tested this hypothesis by comparing mean and maximum measures of surface electromyography (sEMG, MyoTrac Infiniti™) for the submental muscles with/without a 5ml swallow of water, for Resting State, Chin Tuck, and Chin Tuck Against Resistance (= rubber ball).

Main Research Questions:

1. Does S-CTAR cause higher activation of the submental muscles compared to CTAR without swallow?

2. Does S-CTAR cause higher activation of submental muscles compared to Chin Tuck swallow and normal swallow?

METHOD

Participants: *N* = 36 healthy adults (18 males, 21 - 50 years).
Procedure

- Attach sEMG electrodes at the submental location
- Secure iPhone to side of the head to measure angle of head flexion using *Clinometer* application. iPhone screen mirrored to a tablet placed in front of participant for reference
- 3 trials each of 3 tasks in counterbalanced order.

Figure 1. Experimental setup

(1) Resting state/swallow	(2) Chin Tuck/Chin Tuck swallow	(3) CTAR/CTAR swallow
Hold 5 ml of water in mouth, maintain 0° angle of head flexion and swallows after 3 seconds.	Hold 5 ml of water in mouth, chin tuck at an angle 20° and maintain the posture for 3 seconds before swallowing in that position.	Hold 5 ml water in mouth, perform CTAR at an angle of 20° and maintain the posture for 3 seconds before swallowing in that position.

Figure 2. Resting state/swallow, Chin Tuck/Chin Tuck swallow and CTAR/CTAR swallow tasks

*The Chin Tuck / S-CTAR was standardized at 20° from the vertical plane because research has shown that the suprahyoid muscles are activated significantly when the angle of head flexion is 20° (Forsberg et al., 1985).

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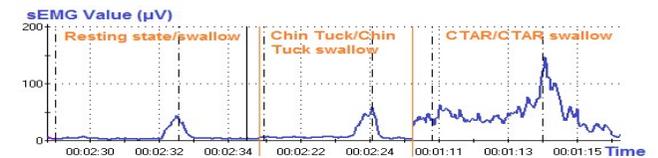
RESULTS

Figure 3. Surface Electromyography signal measured for each of the 3 tasks

- 2x3 (Swallow x Technique) repeated-measures ANOVA was performed on each variable.
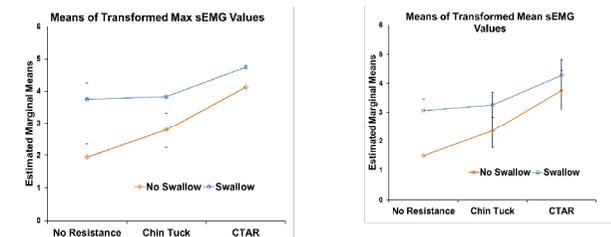

Figure 4. Interaction plot for max sEMG value

Figure 5. Interaction plot for mean sEMG value

- Significantly greater mean and maximum sEMG values were observed during S-CTAR swallow compared to normal swallow and CTAR.
- Swallowing increased sEMG values significantly more when there was no technique used, compared to when CTAR was being performed.

CONCLUSION

- Activation of submental muscles were significantly higher for S-CTAR as compared to CTAR swallow and normal swallow
- S-CTAR is a swallowing exercise that is more effective in activating the submental muscles compared to CTAR alone.
- The impact of this new exercise on the overall swallowing physiology and clinical rehabilitation for patients with dysphagia is the next step.

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