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The Impact of Bowl Feeding on Infant Muscle Activity and Kinematics - An Executive Summary

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Abstract

Addressing difficulties with swallowing is a small, yet critical portion of a speech-language pathologist's role. Infants often experience challenges associated with swallowing safely, yet the ability of SLPs to prescribe effective interventions is limited by the lack of knowledge on how anatomy and physiology interact to drive these challenges. The goal of my Honors Research Project is to address this lack of knowledge by determining how the infant pig tongue moves during feeding from a bottle versus drinking from a bowl, as well as how the muscles controlling the tongue differ in these behaviors. I used infant pigs for this project, since they have the same swallowing mechanisms as human infants. Video data was processed by digitally tracking radio-opaque beads from videos in 3-D in XMALab. Electromyographic data, processed using an established workflow, was utilized to determine muscle activity. By combining these two metrics, I contributed to our understanding of how infants transition to solid foods, providing critical insight on the physiology of this change in feeding. These results will be useful in determining what anatomical and physiological changes occur to better inform clinical practice in helping infants with feeding difficulties.

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Summary

All mammals go through the transition from suckling to drinking. In this experiment, we studied how muscle activity and tongue movements change in the transition from suckling to drinking, since these behaviors are fundamentally different. Many infants struggle to make the transition

from suckling to drinking. To understand why they have these difficulties, we studied this transition in healthy term pigs.

We surgically implanted radio-opaque markers throughout the tongue and hard palate. We also placed EMGs into the relevant muscles – hyoglossus and genioglossus. The genioglossus muscle is a major muscle in the tongue that protrudes and depresses the tongue. The hyoglossus aids in pulling the tongue down during a swallow. One of the advantages of animal studies is that we can measure very specific muscle activities with intramuscular EMGs, that simple surface electrodes in humans cannot. We then filmed the pigs using biplanar videofluroscopy while they fed on a bottle and drank from a bowl. Finally, we tracked the movements of the tongue during suckling and drinking in both views in XMALab and calculated their 3D distance using MAYA and MATLAB programs.

We found that drinking cycle duration and EMG duration both increased during drinking compared to suckling. We also found that the area under the curve (AUC) increased during drinking for the genioglossus muscle, but remained the same in the hyoglossus. This suggests that the genioglossus firing amplitude remained the same across both suckling and drinking, while the hyoglossus firing amplitude decreased during drinking. We also found the anterior, middle, and posterior tongue kinematics change when comparing suckling and drinking. The anterior tongue adjusts directionally when transitioning from suckling to drinking. This suggests the tongue mainly moved up/down when suckling and in/out when drinking. The middle tongue adds anteroposterior movement for bowl drinking. The posterior tongue changes position throughout a cycle and we also found increased dorsal ventral movement while bowl drinking.

Overall, we found that different parts of the tongue musculature change function differently in the transition from suckling to drinking. We must remember that the tongue is more than a single

muscle with uniform movements. The anterior and middle tongue help with the acquisition of food, while the posterior tongue moves the bolus to the valleculae. Understanding of how infants' tongues transition from suckling to drinking provides critical insight into the physiology of this critical transition in infant mammals.