



Acute Changes in the Oral Phase of Swallowing Following Radiation to the Rat Submental Muscles

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Introduction

Radiation based treatments for oropharyngeal cancer can cause swallowing impairments (dysphagia) that negatively influence oral intake and quality of life. There is evidence to suggest that changes in swallowing function begin early after radiation treatment and worsen over time. However, the onset of these behavioral deficits is unclear. Further work is needed to uncover the temporal and functional consequences associated with radiation induced swallowing dysfunction. We used a rodent model of radiation-induced dysphagia⁴ to test the hypothesis that biting and licking function would be impaired in rats immediately after completion of 64Gy of fractionated radiation to the submental muscles.

Methods

Radiation Treatment: Sprague Dawley male rats (N =14) received 64Gy of fractionated radiation or sham treatment with anesthesia only. Radiation was administered to the submental muscles with the mylohyoid at the depth of maximum dose. Clinac iX linear accelerator with 6 MeV electrons was used to administer 8 fractions of 8Gy. The target field was limited to 18x18mm using lead shielding. Superflab material was applied to the dermis to control for the depth of radiation.

Licking Function: Licking activity was recorded using an electrical lick sensor similar to those published previously¹. Rats drank chocolate milk ad libitum in custom-designed cage, which controlled access to drinking tube. Rats were tested in 10-minute drinking sessions after 3hrs of water deprivation. Licking events were analyzed using CED Spike2 software.

Biting Function: To assess if mastication was impaired after radiation to the submental muscles, pasta biting was measured as previously described (2,3). Briefly, rats were given 10 pieces of 7cm long pasta individually in their home cage. Biting behavior was video and audio recorded via Pro-Tools LE software. Video recordings were used to confirm biting episodes. Acoustic signals were analyzed via Spike2 software.

Statistical Analysis: A two-way mixed ANOVA was conducted to determine the interaction and main effects of licking and biting function over the course of treatment.

Licking and Biting Function

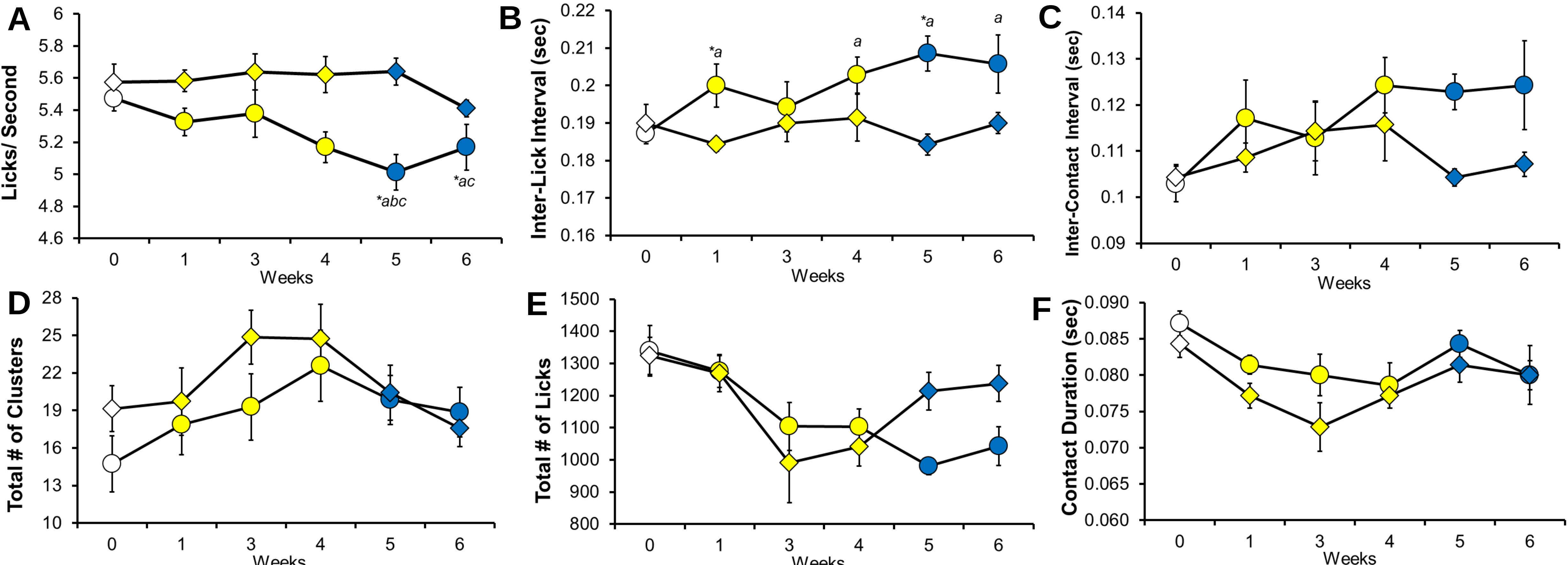


Figure 1. Radiation to the submental muscles alters licking activity. Licking pattern during drinking was analyzed in irradiated (circle) and sham (diamond) treated animals at baseline (white), during treatment (yellow), and post treatment (blue). Statistically significant differences between treatments ($p < 0.05$) is shown as * and letters correspond to differences across time (a to g corresponds to 0-6 weeks). Error bars indicate standard error.

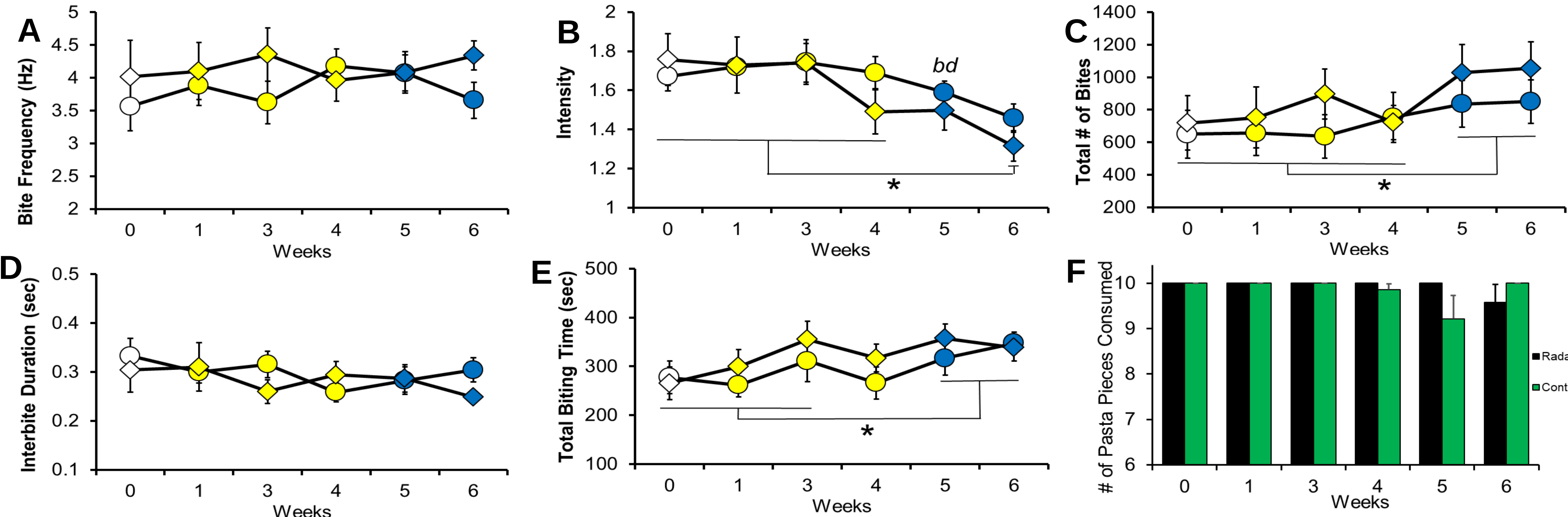


Figure 2. Declines in biting intensity were observed across time. To measure changes in mastication, differences in pasta biting function were compared between radiation (circles) and sham (diamonds) treatment. Testing was performed at baseline (white), during treatment (yellow), and post treatment (blue). Statistical significance of $p < 0.05$ is shown as * and letters correspond to differences between individual time points. Error bars indicate standard error.

Results

- Significantly slower licking frequencies were observed after radiation at 5- and 6-weeks compared to baseline, during treatment, and sham controls.
- Significantly longer pauses between licks (ILI) were observed in irradiated rats at multiple time points compared to baseline and sham controls.
- Biting strength significantly decreased after treatment at 5- and 6-weeks compared to baseline and during treatment
- Rats took significantly more bites and a longer duration of time biting to consume the same amount of pasta pieces after treatment compared to baseline and during treatment.
- No treatment differences were found with biting behaviour

Conclusions

Findings demonstrated that 64Gy of fractionated radiation to the submental muscles alters the licking patterns. Specifically, increases in the duration of time the tongue protrudes and retracts during drinking were observed, which is indicative of an impairment in tongue displacement during drinking. This is clinically significant because the tongue plays a critical role in the oropharyngeal stages of swallowing including bolus formation and bolus propulsion from the oral cavity to the pharynx.

Biting function was not shown to be influenced by treatment, but alterations were found across time. Assuming that biting variables do not change in non-treated, normal rats, then it is possible that this is an effect of repeated anesthesia. Another possibility is that there was a ceiling effect with the biting task.

References

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