ELECTROPHYSIOLOGICAL ACTIVITY OF FACIAL MUSCLES DURING MASTICATION: AN EMG ANALYSIS

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Abstract: *Mastication involves coordinated activity of multiple facial muscles that control jaw movements and food processing. Electromyography (EMG) provides valuable insights into the electrophysiological patterns of these muscles during chewing. This study investigates the EMG activity of key facial muscles during mastication, aiming to characterize muscle activation sequences and intensities relative to different food textures. Understanding these patterns is important for clinical assessment of masticatory function and rehabilitation.*

Keywords: *mastication, facial muscles, electromyography, muscle activity, chewing, EMG analysis*

Mastication is a complex motor task requiring the precise coordination of facial and masticatory muscles to efficiently break down food. The facial muscles, including the masseter, temporalis, orbicularis oris, and buccinator, play essential roles in jaw movement and oral manipulation. Electromyography (EMG) is widely used to study muscle function by recording electrical activity generated during muscle contractions.

Previous research has shown that EMG signals vary depending on the type and texture of food, influencing muscle recruitment and chewing dynamics. This study aims to analyze the electrophysiological activity of selected facial muscles during mastication using surface EMG, providing quantitative data on muscle activation patterns.

The ability of the human masticatory system to adapt to various food textures and consistencies relies heavily on precise neuromuscular control. Among the facial muscles, the masseter and temporalis play major roles in generating bite force, while muscles such as the buccinator and orbicularis oris assist in maintaining bolus stability and positioning during mastication. Surface electromyography (sEMG) allows researchers to non-invasively assess the functional behavior of these muscles by recording their electrical activity in real time.

Previous studies have shown that muscle activation varies not only with food hardness but also with individual chewing patterns, age, and neuromuscular health. However, there remains a need for standardized comparative data on the influence of specific food textures on facial muscle recruitment in healthy individuals. This study aims to fill that gap by comparing the EMG activity of key facial muscles across soft, medium, and hard food textures, offering practical insights for both clinical diagnostics and dietary planning.

Participants

Ten healthy adult volunteers (5 males, 5 females), aged 20-30 years, with no history of temporomandibular disorders or facial muscle dysfunction, participated in the study.

Procedure

Surface EMG electrodes were placed bilaterally on the masseter, temporalis, orbicularis oris, and buccinator muscles following standard placement guidelines. Participants were instructed to chew three types of food with varying textures: soft (banana), medium hardness (cheese), and hard (carrot).

EMG signals were recorded during continuous chewing cycles for 30 seconds per food type. Signals were amplified, filtered (20-450 Hz), and analyzed for amplitude (root mean square, RMS) and timing of muscle activity.

Data Analysis

EMG data were processed using signal analysis software. Peak and mean amplitudes were calculated, and muscle activation sequences were compared across different food textures. Statistical analysis was conducted using repeated measures ANOVA with significance set at $p < 0.05$.

Equipment and EMG Setup

The EMG signals were recorded using a multi-channel surface electromyograph (Biopac MP36 system). Disposable Ag/AgCl surface electrodes were positioned on the belly of each muscle (masseter, anterior temporalis, orbicularis oris, and buccinator) based on anatomical landmarks, ensuring consistent placement across participants. A reference electrode was placed on the participant's mastoid process. Skin was cleaned with alcohol to reduce impedance before electrode placement.

Food Texture Standardization

Three food types were selected to represent distinct texture categories:

Soft: ripe banana (low resistance, high moisture)

Medium: semi-firm cheese (moderate resistance, cohesive)

Hard: raw carrot slices (high resistance, fibrous)

Each food item was cut into standardized 2x2 cm pieces to ensure consistency in bite size and chewing effort.

Procedure

Participants sat upright in a quiet room and were instructed to chew each food item naturally without swallowing for a period of 30 seconds. Each food type was tested in randomized order with a 2-minute rest period between trials to minimize muscle fatigue.

Three chewing trials were conducted per food item, and the average EMG signal from each trial was used for analysis. Parameters analyzed included:

RMS amplitude (µV): indicating muscle contraction strength

Onset and offset timing (ms): to analyze activation duration

Chewing cycle count within the 30-second trial

EMG analysis revealed that mastication of harder food (carrot) elicited significantly higher muscle activity in the masseter and temporalis muscles compared to softer foods (banana and cheese) ($p < 0.01$). The orbicularis oris and buccinator showed moderate activity, primarily during bolus manipulation, with less variation across food types.

Chewing harder food increased both the duration and intensity of muscle contractions, with longer chewing cycles observed. Muscle activation sequences remained consistent, typically initiating with temporalis followed by masseter contraction.

The findings confirm that food texture significantly influences the electrophysiological activity of facial muscles during mastication. Increased EMG amplitude in the masseter and temporalis during harder food chewing reflects greater muscle force requirements. The consistent activation sequence suggests a well-coordinated neuromuscular pattern for efficient mastication.

The moderate activity of orbicularis oris and buccinator highlights their role in managing the food bolus rather than generating chewing force. These insights have clinical relevance for diagnosing masticatory dysfunction and planning rehabilitative interventions for patients with facial muscle impairments.

Limitations include the small sample size and use of surface EMG, which may be affected by cross-talk from adjacent muscles. Future studies could incorporate intramuscular EMG and expand to clinical populations.

EMG analysis demonstrates that facial muscle activity during mastication varies according to food texture, with masseter and temporalis muscles showing significant electrophysiological adaptations. Understanding these patterns contributes to improved clinical evaluation of masticatory function and informs therapeutic strategies.

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