Alternating activities of masseter and digastric muscles in growing rats fed a kneaded diet

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Abstract. To investigate the effect of breeding with the kneaded diet on the development of alternating activities of the masseter (Ma) and anterior digastric (Di) muscles during chewing, 41 Wistar male rats were divided into the solid (group S, \(n = 20\)) and the kneaded (group K, \(n = 21\)) diet groups at 16 days of age, and bred until 11 weeks of age. Electromyograms of Ma and Di were recorded during the solid pellet chewing at 5, 8 and 11 weeks of age. Ten successive chewing cycles of the last stage of chewing were analyzed.

Cycle length did not change after 5 weeks of age in each group. In group K, the time-lag of activity onset from Ma to Di was significantly larger, and that from Di to Ma was significantly smaller at every stage of development. Overlap of burst durations of these muscles significantly decreased with the decrease of burst duration of Ma after 5 weeks of age and was significantly smaller at 11 weeks of age in group K.

The hypothesis that jaw muscle activities may be more developed in rodents fed a kneaded diet than in those fed a solid diet was confirmed by the present study.

Keywords: development, EMG, jaw muscles, mastication.

Introduction

According to Aihoshi [1], occlusal tooth wear on molars was wider, deeper and smoother in mice fed a kneaded diet than in mice fed a solid diet. The reason might be that the mice spent a great deal of labor gnawing a solid pellet with their incisors, while in the case of a kneaded clot they did so chewing on their molars. As mastication has a definite influence on the development of masticatory muscles and jaw bones [2], it is hypothesized that jaw muscle activities may be more developed in animals fed a kneaded diet than in those fed a solid diet. The aim of the present study is to investigate the development of alternate activities of jaw-opening and -closing muscles during chewing in rats fed a kneaded diet.

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Animals and Methods

Forty-one Wistar male rats were divided into the solid (group S, n = 20) and the kneaded (group K, n = 21) diet groups at 16 days of age and bred until 11 weeks of age.

Electrodes were installed to the left masseter (Ma), jaw-closing muscle, and the anterior digastric (Di), jaw-opening muscle, at 4 weeks of age according to Liu et al. [3]. EMG activities of these two muscles were recorded during the solid pellet chewing at 5, 8 and 11 weeks of age. The following EMG variables were measured from 10 successive chewing cycles of their last stages of chewing: 1) cycle length defined as the length from the beginning of an activity onset to the beginning of next activity onset of Ma; 2) time-lag of activity onset from Ma to Di; 3) time-lag of activity onset from Di to Ma; 4) burst duration of Ma; and 5) overlap of burst durations of Ma and Di. They were divided by the corresponding cycle length.

Results

Though cycle length did not change from 5 to 11 weeks of age in each group, it showed a significant difference between both groups at 5 weeks of age (Table 1). The time-lag of activity onset from Ma to Di was significantly larger, and that from Di to Ma was significantly smaller at every stage of age in group K. However, they did not change from 5 to 11 weeks of age in each group.

The burst duration of Ma decreased significantly from 5 to 11 weeks of age in group K, but did not change in group S. It was significantly larger at 5 and 8 weeks of age in group K. The overlap of burst durations of Ma and Di decreased significantly from 5 to 11 weeks of age in group K, but increased in group S. It was significantly larger at 5 weeks of age, and smaller at 11 weeks of age in group K.

Discussion and Conclusion

According to Liu et al. [3], the development of EMG timing pattern of jaw muscles in rats was influenced by the property of the breeding diet. In the present study, the time-lag of activity onset from Ma to Di was larger, and that from Di to Ma was smaller after 5 weeks of age in group K (Table 1). This means that dominant separation of activity onset of these two muscles was attained by 5 weeks of age in group K.

Burst duration of Ma decreased significantly from 5 to 11 weeks of age in group K (Table 1). As group K took the solid diet for the first time at the EMG recording of 5 weeks of age, they might take a longer time for chewing the diet on molars than group S. After 5 weeks of age, the decrease in burst duration of Ma was interpreted as a decrease with growth, and this change contributed to the decrease in the overlap of burst durations of Ma and Di in group K. As a result, the overlap of burst durations of Ma and Di was smaller at 11 weeks of
<table>
<thead>
<tr>
<th>Number of cycles</th>
<th>5 weeks of age</th>
<th>8 weeks of age</th>
<th>11 weeks of age</th>
<th>F ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cycle length (ms)</td>
<td>215.1 ± 25.6</td>
<td>197.9 ± 18.1</td>
<td>202.1 ± 24.0</td>
<td>189.7 ± 19.1</td>
</tr>
<tr>
<td>Time-lag of activity onset from Ma to Di (% of cycle length)</td>
<td>6.8 ± 7.6</td>
<td>17.0 ± 8.4</td>
<td>7.6 ± 4.6</td>
<td>24.0 ± 14.0</td>
</tr>
<tr>
<td>Time-lag of activity onset from Di to Ma (% of cycle length)</td>
<td>92.8 ± 7.7</td>
<td>83.1 ± 8.2</td>
<td>92.6 ± 4.6</td>
<td>76.7 ± 14.1</td>
</tr>
<tr>
<td>Burst duration of Ma (% of cycle length)</td>
<td>42.2 ± 8.0</td>
<td>62.4 ± 7.1</td>
<td>45.6 ± 9.4</td>
<td>59.6 ± 9.7</td>
</tr>
<tr>
<td>Overlap of burst duration of Ma and Di (% of cycle length)</td>
<td>29.9 ± 10.2</td>
<td>45.3 ± 11.1</td>
<td>37.9 ± 9.0</td>
<td>35.9 ± 14.0</td>
</tr>
</tbody>
</table>

p values by nonpaired t test: ;^ap < 0.05; ;^b p < 0.01; ;^c p < 0.001, by ANOVA or SNK test: ;^d p < 0.05.
age in group K. The alternating activities of Ma and Di were considered to be matured at 11 weeks of age in group K.

It was concluded that the alternating activities of jaw-opening and -closing muscles during chewing was more developed in mice fed a kneaded diet.

References