Introduction

This article reviews and acquaints the findings of original papers in the area of occlusion and jaw function published in the Journal of Japan Prosthodontic Society (JJP, J Jpn Prosthodont Soc; Nippon Hotetsu Shika Gakkai Zasshi in the Medline/ PubMed) issued in Volume 49, 2005. The findings of the original papers in the area of dental material and devices were already reviewed in the preceding issue. Articles on occlusion and jaw function dominated during the last 40 years in the Journal of Japan Prosthodontic Society, and formed 20% - 30% of all the contributed papers. This rate is indeed remarkable when compared with the other major international journals, and it has been the feature of prosthodontic research in this country (Fig. 1).

A total of 7 articles related to mandibular movement, masticatory movement, brain function, and sleep were selected. It was suggested that the results of the selected researches provided new outlook in occlusion and masticatory function, and contributed greatly to dental medicine.

Mandibular movement

When jaw function is normal, the condyles of both sides move in cooperation during opening and closing movements. However it has been demonstrated that when an obstacle arises in TMJ or masticatory muscle, and if a jaw function becomes unusual, a difference will arise in the extent of movements or activity of the condyle on either side. Therefore the movement of condyle has been investigated for detecting TMJ or muscle dysfunction and for identifying the cause. Ando et al investigated whether the rotation and translation of the condyle were useful parameters for identifying the causes of the limitation of mouth opening in patients with temporomandibular dysfunction. They found that both rotation and translation of the condyle were strongly correlated with maximum mouth opening, and that muscle pain was associated with reduced mouth opening and rotation. The amount of mouth opening and rotation were significantly smaller in patients with muscle pain than in patients without muscle pain (Table 1). They found that the amount of rotation of the condyle before the procedure was small in patients who did not respond well to arthrocentesis treatment. This may indicate that the limitation of mouth opening in the patients with small rotation of the condyle may be of myogenous origin, and that the procedure of arthrocentesis should not be performed on them.

Although the dynamic properties of the condyles of both sides influence are known to influence the functions of masticatory muscles and TMJ, their relevance has not been clearly established. Yamamura et al evaluated the relation between the dynamic properties of the condyles of both sides during habitual maximum opening and closing movements and the occlusal force balance during clenching. For assessing the dynamic properties of the condyles, the rate of translation and rotation were plotted on a graph using the translation-rotation relative chart, and the maximum difference (d) of translation in rotation between the right and left condyles was calculated. For assessing the occlusal force balance, the center of gravity of the occlusal force measured using a Dental prescale was applied. They found that the center of gravity of the occlusal force...
was almost localized on the median line in the right-left dimension and was localized on the molar tooth area in the anterior-posterior dimension. These observations were largely in agreement with previous reports.\textsuperscript{9,10} There was a significant correlation between the coordinate value of the center of gravity of the occlusal force in the right-left dimension and the path of closing’s (d) ($r=0.71$, $P<0.05$). These results suggest that the occlusal force balance is associated with the dynamic properties of the condyles of both sides, and that the dynamic properties of the condyles might be estimated from the occlusal force balance.

**Masticatory movement**

It has been reported that the number of chewing strokes prior to the point of first swallowing is large and that the rate of storage of ground food

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**Table 1** Pain related each parameter.

<table>
<thead>
<tr>
<th>Pain</th>
<th>Range of mouth opening (mm)</th>
<th>Rotation (°)</th>
<th>Translation (mm)</th>
<th>Range of mouth opening (mm)</th>
<th>Rotation (°)</th>
<th>Translation (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(+) 36</td>
<td>32.6 (35.0±1.36)</td>
<td>21.5 (23.3±1.13)</td>
<td>13.1 (12.3±0.89)</td>
<td>(+) 25</td>
<td>32.3 (34.4±1.59)</td>
<td>21.7 (22.9±1.36)</td>
</tr>
<tr>
<td>(-) 19</td>
<td>43.9 (10.6±2.08)</td>
<td>*</td>
<td>*</td>
<td>(-) 30</td>
<td>39.9 (40.2±1.69)</td>
<td>28.1 (27.1±1.29)</td>
</tr>
<tr>
<td>(+) 24</td>
<td>36.7 (35.9±1.80)</td>
<td>23.7 (24.3±1.47)</td>
<td>13.8 (13.7±0.99)</td>
<td>(-) 31</td>
<td>40.5 (39.1±1.67)</td>
<td>27.7 (26.1±1.28)</td>
</tr>
</tbody>
</table>

*: $P<0.05$, Median (Mean±SE)
particles in the oral vestibule is higher during unilateral chewing than during free sided chewing. However, the oral condition, such as amount of saliva, occlusal force, and occlusal contact, were not taken into account in this investigation. Honma et al.\(^{12}\) investigated the number of chewing strokes for peanuts prior to the point of first swallowing in 116 healthy dentate subjects chewing peanuts on unilateral side or free side. The number of chewing strokes in free sided chewing group was 10% less than that in unilateral chewing group. This may indicate that the movement after taking the food into the mouth until the swallowing is performed more efficiently. After measurement of three parameters, namely, amount of salivary secretion, occlusal force, and contact points of the posterior teeth, the subjects were classified into high score group and low score group based on the average score for each parameter. The numbers of chewing strokes during free sided chewing were all less than those of unilateral chewing in both group on three parameters. The rate of remaining coarse particles during free sided chewing was significantly smaller than that during unilateral chewing in the low score group for salivary secretion (Table 2) and occlusal force. These results show that the masticatory efficiency during free sided chewing is high, irrespective of the amount of salivary secretion, occlusal force, and contact points, as compared with that during unilateral chewing. This may indicate that elderly people in whom the occlusal force and/or salivary secretion is reduced should be advised to perform free sided chewing rather than unilateral chewing for mastication.

Unno et al.\(^{13}\) after classifying the masticatory path of 65 healthy subjects into eight patterns (Fig. 3) and measuring glucose extraction as an indicator representing masticatory efficiency, compared the masticatory efficiency between each of two patterns, and then investigated the relationship between path stability and masticatory efficiency. They found that the amount of glucose extraction was highest for the pattern I, followed by pattern III, V, II, VII, IV, VI, and VIII. Statistically significant differences were found between pattern I and all the other patterns, between II and III, and IV, VI, VII, V and VI, VI and VII respectively (Fig. 4). This indicates that just as there are functional differences in the stability of masticatory path, there are also functional differences among patterns. The masticatory efficiency increased with increase in the stability of the pattern, and a highly significant correlation was found between the two (\(r=0.929, P<0.01\)). It was concluded that there was a close correlation between masticatory efficiency and masticatory path pattern, and that by quantitatively analyzing masticatory path pattern it may be possible to objectively evaluate masticatory function. The results may indicate that masticatory efficiency could be presumed from the stability of masticatory movement, and in order to raise masticatory efficiency, it would be necessary to achieve stability of movement.

### Brain function

Taste plays an indispensable role in dietary preference, and its impairment may lead to a decline of the QOL; therefore, it is important to examine impairment in the ability to taste. Mushimoto et al.\(^{14}\) investigated whether gustatory-evoked potentials were useful objective evaluation of taste. The tongue and soft palate of 15 healthy subjects were stimulated under 7 conditions of duration of

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**Table 2** The relation between the amount of saliva secretion and chewing strokes (\(n=116\)).

<table>
<thead>
<tr>
<th>Group (1.7ml below)</th>
<th>n</th>
<th>Masticatory method</th>
<th>Number of chewing strokes</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low score</td>
<td>64</td>
<td>Free-sided chewing</td>
<td>32.3±10.9</td>
<td>3.0±7.2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Unilateral chewing</td>
<td>35.3±10.3 #</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Right-side chewing</td>
<td>35.3±9.9</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Left side chewing</td>
<td>35.2±10.8</td>
<td></td>
</tr>
<tr>
<td>High score (1.7ml above)</td>
<td>52</td>
<td>Free-sided chewing</td>
<td>31.7±12.0</td>
<td>4.3±9.1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Unilateral chewing</td>
<td>36.0±12.5 #</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Right-side chewing</td>
<td>35.3±12.0</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Left side chewing</td>
<td>36.7±13.0</td>
<td></td>
</tr>
</tbody>
</table>

*Average of right and left side chewing. *\(P<0.01\)
stimulation (1,000, 500, 300, 200, 120, 100, and 70 msec) using an electrogustometer. Electroencephalograms were recorded from 19 sites using the 10/20 International System standard. For judging the quality of taste, the number of subjects in whom induced taste decreased when the stimulus duration was reduced to less than 100 msec. In regard to the cerebral-evoked potentials noted at 9 sites, three peaks (P1, N1, P2) were observed when taste was induced in the subjects (Fig. 5). While no significant change in the peak latencies, significant increase of the N1-P2 amplitude was observed. These results suggest that P2 may be considered as a gustatory-evoked potential, and also that objective evaluation of gustatory sense may be possible by recording gustatory-evoked potentials using an electrogustometer.

Sleep

Although one of the causes of dislodgement of dental restorations is considered to be bruxism during sleep (SB), this causal relationship has not fully been resolved yet. Investigating the influence of SB on the dislodgement of dental restorations is very important for obtaining a good prognosis for dental restorations. Tomonaga et al. investigated the correlation between the strength of SB and the dislodgement rate of dental restorations in 422 patients referred to the hospital between 1976 and 2004. The subjects were classified into four groups according to the strength of bruxism: B-0: no facet on the splint, B-1: slight facet with wearing off of the ink but no indentation on the splint, B-2: slight indentation on the splint, and B-3: notable indentation on the splint. The mean evaluation time for the B-1, B-2, and B-3 groups was 10.1 years, 10.3 years, and 9.5 years respectively. The percentage of patients with dislodgement in the B-1, B-2, and B-3 groups was 12.7%, 35.1%, and 43.8% respectively, and significant differences were observed between the B-1 and B-2 groups, and between the B-1 and B-3 groups.
These results suggested that the dislodgement of the dental restorations was related to the strength of sleep bruxism and that evaluation of the strength of sleep bruxism may be effective for predicting dislodgement. These may suggest that the frequency of dislodgement of dental restorations can be decreased if the strength of sleep bruxism can be reduced.

Oral appliance with jaw forward position is used as one of the treatments for the obstructive sleep apnea syndrome (OSAS)\textsuperscript{16, 17} and it is said that sleeping in the lateral recumbent position is effective.\textsuperscript{18} Tsuda and Masumi\textsuperscript{19} evaluated whether any substantial airflow changes occurred with changes of the jaw position (0%F: 0% jaw forward position, 50%F: 50% jaw forward position, 75%F: 75% jaw forward position) and body posture position (supine position and lateral recumbent position) in 15 healthy subjects and 15 patients with OSAS. The maximum forced inspiratory flow (FIF) curve was measured in all of the subjects. In the healthy subjects, while the FIF increased with a change of the body posture from the supine to the lateral recumbent position, no increase was found with increasing jaw forward position. On the other hand, in the OSAS patients, the FIF increased as the jaw forward position was increased although there was no significant difference between the 50%F and 75%F conditions in the supine position. The results suggested that for a patient in the lateral recumbent position, the treatment with the oral appliance was more effective in the 75% jaw forward position than in the 50% jaw forward position, whereas for a patient in the supine position, there was no difference in the efficacy between the 50% jaw forward position and 75% jaw forward position.

References