Chewing Patterns in Subjects with Normal Occlusion and With Malocclusions

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This report describes the chewing patterns of individuals with normal occlusion and several types of malocclusion. Frontal movement patterns of the lower mid-incisor point were recorded during chewing of test foods in groups of subjects with Angle Class I normal occlusion, Class II malocclusion, as well as deep-bite and cross-bite malocclusions. Mandibular prognathic and retrognathic patients corrected to Angle Class I occlusions were also examined before and after orthognathic surgery. Chewing patterns were classified by using a catalogue of eight basic movement types. In none of the groups examined could chewing behavior be characterized by only one specific type of movement, but rather by different frequency distributions of pattern types. The Angle Class I, Class II, deep-bite, and presurgical retrognathism groups were characterized by chewing patterns with normal sequencing and grinding features and, to a minor extent, by self-crossing movements having no unique pattern of sequencing. Reversed sequencing did not occur in these four groups. In presurgical prognathic patients, drop-shaped patterns with steep closing movements predominated. Cross-bite malocclusion was characterized by drop-shaped and reversed sequencing patterns. The pattern distribution in prognathic patients did not change after surgery. In retrognathic patients the therapeutically altered occlusion caused a decrease in the frequency of grinding movements and an increase in the frequency of drop-shaped patterns. (Semin Orthod 2006;12:138-149.)

Orthodontic or surgical treatments of malocclusion and dysmorphology aim at restoring or improving patients' functional abilities. Function has been typically assessed by examining jaw muscle activity,[1-5] bite-forces,[1-3,6] food breakdown,[7-9] or jaw movements.[1,10-20] Because jaw movements are guided by neuromuscular control in accordance with the constraints imposed by the temporomandibular joints and occlusion, they have proven useful for evaluating chewing function.

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To specify the term *chewing* or *masticatory pattern,* one has to consider that no unique movement can be assigned to the jaw as a whole because separate areas, for example, the temporomandibular joints and incisors, can move quite differently from each other. However, as demonstrated by Gibbs and coworkers,[20] trajectories of the posterior teeth are quite similar to those of the incisors. Based on this similarity, tracking of the lower mid-incisor point has become a standard tool for the analysis of masticatory movement. Accordingly, the term "chewing" or "masticatory pattern" denotes the graphic superposition of consecutive chewing cycles of the lower mid-incisor point, evaluated in a frontal view.

Chewing patterns were first studied by Ahlgren,[13] who found that children with normal occlusion displayed regular types of movement, whereas children with malocclusion displayed predominately chopping, reversed, contralat-

eral, and self-crossing masticatory strokes. Gibbs and coworkers[20] reported similar observations and identified the so-called drop-shaped chewing pattern as the normal mode of mastication. These early studies established the accepted view that normal chewing function is associated with so-called normal masticatory movements, whereas malocclusions show "abnormal" movement patterns. Since such classifications lacked information on functional capabilities, more recent studies have focused on chewing performance and efficiency. The present report evaluates the relationships between chewing patterns and occlusion, and synthesizes the available information pertaining to masticatory patterns and chewing efficiency.

Materials and Methods

Untreated Groups

The sample of untreated subjects included 247 dental students selected using criteria recommended by Gibbs and Lundeen[21] including proper chewing function, complete dental arches, no symptoms or signs of craniomandibular disorders, and no severe dysmorphology. The 247 subjects were divided into four groups according to their occlusions (Table 1): 159 subjects with Angle Class I normal occlusions, 46 subjects with Angle Class II malocclusions (incisal vertical overlap of less than 4 mm), 21 subjects with deep-bite malocclusions (incisal vertical overlap of more than 4 mm), and 21 subjects with posterior cross-bite malocclusions (7 had right-side cross bites, 8 had left-side cross bites, and 6 had bilateral cross bites).

Surgically Treated Groups

In addition to the untreated subjects, 20 patients with mandibular prognathism and 17 with retrognathism, who had undergone surgical setbacks or advancements of their mandibles, respectively, were evaluated before and 6 months after surgery (Table 1). All of the surgical patients underwent presurgical orthodontic treatment and had Class I occlusions after surgery. The prognathic and retrognathic groups made it possible to investigate how changes of occlusion affect chewing behavior. Masticatory movements of all patients were recorded a few days before surgery and about 6 months later, after they had adapted to their corrected occlusions.

Experimental Protocol

For each subject in the untreated and treated groups, chewing movements were recorded using the Sirognathograph. This system has been described and its accuracy has been tested.[22,23] It consists of a small magnet attached to the lower mid-incisors and an antenna, carrying semiconductor sensors, fixed to the head. The sensors measure changes in the magnetic field due to the movement of the magnet. Gummibears and equally sized pieces of bread, without crust, were used as tough and soft foods, respectively. These two textures were selected as extremes evoking

Table 1. Sample Size, Clinical Criteria, and Occlusal Status of Subjects with Normal and Malocclusion Evaluated

Groups	*Number of Subjects*	*Clinical Criteria*	*Occlusal Status*
Angle Class I	159	Nonpatient	Normal occlusion
Angle Class II	46	Nonpatient; no skeletal discrepancies	Malocclusion, vertical incisal overlap <= 4 mm
Deep-bite	21	Nonpatient; Angle Class II, no skeletal discrepancies	Malocclusion, vertical incisal overlap > 4 mm
Cross-bite	21	Nonpatient; Angle Class I or II, no skeletal discrepancies	Malocclusion, 27 lateral dental arches
Retrognathic presurgical	17	Patient; Angle Class II, skeletal discrepancies	Malocclusion
Retrognathic postsurgical	17	Patient; corrected to Angle Class I	Normal occlusion
Prognathic presurgical	20	Patient; Angle Class III, skeletal discrepancies	Malocclusion
Prognathic postsurgical	20	Patient; corrected to Angle Class I	Normal occlusion