Reverse cycle chewing before and after orthodontic-surgical correction in class III patients

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Objective. The aim of this study was to investigate the prevalence of reverse-sequence chewing cycles in skeletal class III patients before and after orthodontic-surgical therapy to evaluate whether the occlusal and skeletal correction is followed by a functional improvement.

Study Design. Twenty skeletal class III patients (11 males and 9 females, 22.7 ± 3.0 years old) were recruited for this study. All patients received orthodontic and surgical treatment. Chewing cycles were recorded with a kinesiograph before (T0) and after (T1) therapy.

Results. A significant decrease in the number of reverse chewing cycles after surgical correction was exhibited in all recordings, when chewing either soft or hard boluses, on both the right and the left side.

Conclusions. Evaluation of the prevalence of reverse chewing cycles could be considered an indicator of functional adaptation after therapy and a method for the early detection of nonresponding patients who may require further consideration using a different approach. (Oral Surg Oral Med Oral Pathol Oral Radiol 2013;115:328-331)

Mastication is a dynamic process characterized by rhythmicity and a diversity of jaw patterns, established through the integration between the peripheral and cortical inputs and the pattern generator in the brain stem.[1]

Jaw movements are adjusted by mechanoreceptors located in the tongue, oral mucosa, muscle spindles, and periodontal pressoreceptors. The pattern of mandibular movement during chewing is influenced by factors such as bolus type and type of occlusion.[2,3] The relative position of the upper and lower teeth determines occlusal stability, which is related to muscular performance.

Patients with severe dentofacial deformities, including congenital and acquired jaw discrepancies, require orthodontic therapy and orthognathic surgery to correct their altered facial morphology and occlusion.[4] Skeletal, occlusal, and esthetic outcomes are predictable, but disagreement exists with regard to the functional effects on the stomatognathic system,[5-8] although some recent articles report improvement in functional parameters.[9]

The changes occurring in dentition[10] after orthognathic surgery are dramatic and the precise knowledge of the adaptation taking place in the motor control of the masticatory function after surgery is of interest for both dentists/orthodontists and surgeons.

Reverse-sequence chewing cycles are diskinetic movements characterized by altered muscular activation[11] and a reduction of all parameters of masticatory efficiency.[12] The decrease in the number of reverse cycles is considered of utmost importance as an indicator of improved functional balance.[13]

The aim of this study was to investigate the prevalence of reverse-sequence chewing cycles in adult skeletal class III patients before and after orthodontic-surgical correction to evaluate whether occlusal and skeletal normalization is followed by functional improvement.

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Statement of Clinical Relevance

The evaluation of the prevalence of reverse chewing cycles could be considered an indicator of the functional adaptation after therapy and a method for the early detection of nonresponding patients who may require further consideration using a different approach.

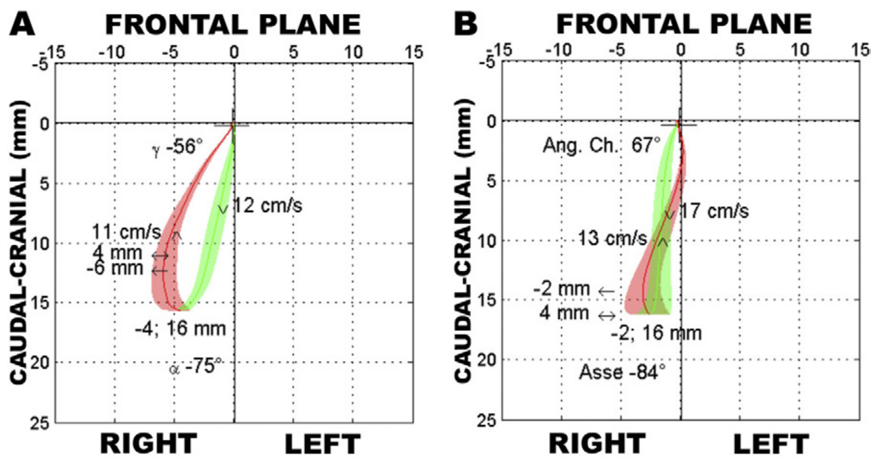

Fig. 1. (a) Normal chewing pattern. (b) Reverse chewing pattern.

MATERIAL AND METHODS

Twenty skeletal class III adult patients (11 males and 9 females, 22.7 ± 3.0 years old [mean ± standard deviation]) were recruited from June 2001 through December 2004 to participate in this longitudinal study, and informed consent was obtained from all subjects.

Inclusion criteria were as follows: skeletal and dental severe, surgical class III[14]; and presence of all teeth (with the exception of the third molars, which were routinely extracted at the beginning of treatment, if present).

Exclusion criteria were as follows: presence of fixed or removable dental prosthesis; periodontal disease; and presence of craniofacial syndromes or clefts.

Each patient received presurgical and postsurgical orthodontic treatment for 36 ± 12 months [mean ± standard deviation], with fixed appliances. The same 2 surgeons, who had over 10 years of experience in orthognathic surgery, operated on all patients. Four patients received bilateral sagittal split (BSSO) to reduce mandibular excess, 3 received LeFort I osteotomy for maxillary advancement, and 13 received combined BSSO and LeFort I osteotomy. Fixation of the mandibular segments was performed with 1 titanium individually bent miniplate and 4 monocortical screws per side, and the maxilla was fixed with 4 miniplates. Intraoperative manual seating of the condyle in the passive dorsocranial position in the glenoid fossa was performed in all cases, whereas the distal fragment was held in planned occlusion with temporary intermaxillary fixation. No postoperative intermaxillary fixation was used, light guidance elastics were placed to maintain the ideal occlusion for 2 weeks, and a soft diet was suggested for 4 weeks.

All patients underwent the following: (1) chewing cycle recording before orthodontic treatment (T0); (2) orthodontic treatment before surgery; (3) surgical correction of skeletal class III malocclusion; (4) orthodontic refinement after surgery; and (5) postorthodontic chewing cycle evaluation (T1).

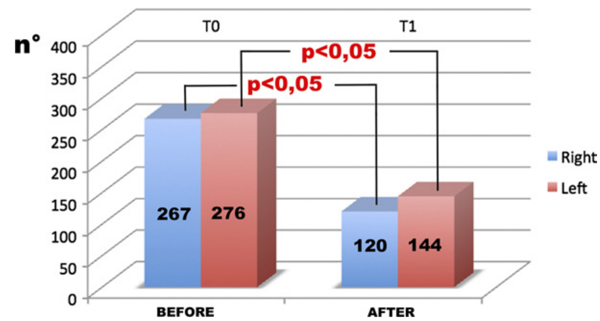

Fig. 2. Reverse sequencing chewing cycles, soft bolus.

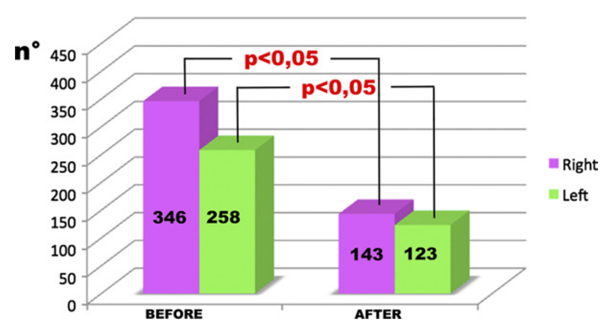

Fig. 3. Reverse sequencing chewing cycles, hard bolus.

The patients were comfortably seated on a chair. They were asked to fix their eyes on a target on the wall, 90 cm directly in front of their seating position, avoiding movements of the head. The recordings were performed in a silent and comfortable environment. Each recording began in natural occlusion. The patients were asked to find this starting position by lightly tapping their opposing teeth together and clenching. They were asked to hold this position with the test bolus on the tongue, prior to starting the

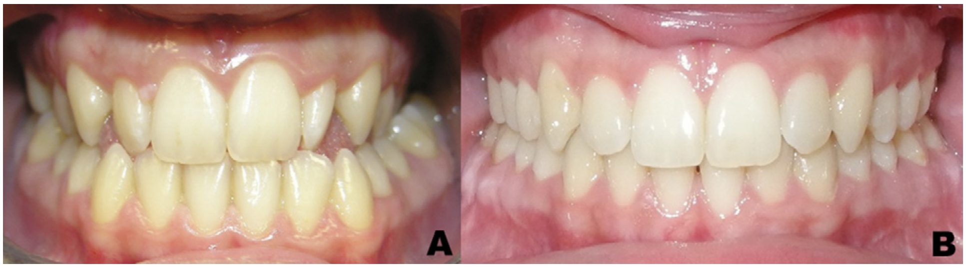

Fig. 4. Chewing patterns of skeletal class III patients (a) before and (b) after orthodontic-surgical correction.

recording. The patients were instructed to chew a soft bolus and then a hard bolus, deliberately on the right and left sides. The duration of each test was 10 seconds and each set was repeated 3 times. The side of mastication was visually checked by the operator. The soft bolus was a piece of chewing gum and the hard bolus was a wine gum; the boluses were the same size (20 mm in length, 1.2 mm in height, and 0.5 mm in width) but different weights (2 g for the soft bolus and 3 g for the hard bolus).

Mandibular movements were measured with a kinesiograph (K7, Myotronics Inc, Tukwila, WA), which measures jaw movements within an accuracy of 0.1 mm. Multiple sensors (Hall effect) in a light-weight array (113 g) tracked the motion of a magnet attached to the midpoint of the lower incisors.[12] The kinesiograph was interfaced with a computer for data storage and subsequent analysis.

The kinematic signals were analyzed using custom-made software (Department of Orthodontics and Gnathology, Dental School, Turin University, Turin, Italy). The first cycle, during which the bolus was transferred from the tongue to the dental arches, was excluded from the analysis. The chewing cycles were divided into nonreverse and reverse on the basis of the vectorial direction of closure (Figure 1).

Statistical analysis was performed with the χ^2 test to compare data at T0 and T1.

RESULTS

The results showed the following: (1) an increasing trend in the total number of chewing cycles after therapy in all recordings (T0-T1)—soft bolus: right side (587 before, 674 after) and left side (648-684); hard bolus, right side (586-695) and left side (576-692); (2) a significant decrease in reverse-sequencing chewing cycles after therapy in all recordings (Figures 2 and 3)—soft bolus: right side (267-120; $P < 0.05$) and left side (276-144; $P < 0.05$); hard bolus: right side (346-143; $P < 0.05$) and left side (258-123; $P < 0.05$); and (3) a decreasing trend in proportion (%) of reverse chewing cycles after surgical correction in all recordings—soft bolus: right side (45.5%-17.8%) and left side (42.6%-21.1%); hard bolus: right side (59%-20.6%) and left side (44.8%-17.7%).

DISCUSSION

In this study, the chewing patterns of skeletal class III patients were investigated before and after orthodontic-surgical correction (Figure 4) by recording the prevalence of reverse chewing cycles. This analysis provides indications on the functional adaptation of the masticatory system after orthognathic surgery.

The results of this study showed that the percentage of reverse-sequence chewing cycles was significantly lower after therapy with respect to the percentage before therapy, both with soft or hard bolus and during chewing on the left and right sides. Our results are in agreement with those of previous studies,[15-18] but the method used is different and original.

During normal chewing, the mandible deviates laterally toward the bolus side and then medially during closure through the transcuspal and intercuspal phases of mastication.[19] In the reverse-sequence cycle, the mandible first deviates medially and then laterally, thus ensuring overlap of opposing dental occlusal surfaces. This reverse chewing pattern is dependent on central motor control established through the integration between the peripheral and cortical inputs. Reverse chewing cycles show an abnormal, narrow pattern characterized by smaller lateral displacement, crossover of the opening and closing pattern, slower velocity of the mandible, and altered coordination of the masseter muscles[20-22] of both sides in comparison with normal chewing. Reverse-sequence chewing cycles occur, with high proportion, during chewing on the crossbite side in patients with posterior crossbite.[10,11,13,23-25] The cycles are diskinetic movements characterized by little variability, excessive repetitiveness, and altered muscular activation, resulting in a reduction in all parameters of masticatory efficiency.[3]

In this study the decrease in the percentage of reverse-sequence chewing cycles after surgical therapy in all recordings (both sides and both boluses) indicates that a significant number of chewing cycles are now smooth and the kinematic of the mandible is becoming more regular and symmetric.

This functional improvement suggests that the masticatory system maintains adaptive capability in adults and that surgical correction of skeletal class III occlusion improves masticatory muscle balance.

Considering the risk of post-treatment relapse and adverse side effects on the masticatory system, which compromises the clinical outcome of orthognatic surgery, evaluation of the prevalence of reverse-chewing cycles may represent a method for the early detection of nonresponding patients who might require further treatment using a different approach.

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