AperTO - Archivio Istituzionale Open Access dell'Università di Torino

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

This is the author's manuscript

Original Citation:

Availability:

This version is available <http://hdl.handle.net/2318/127754> since 2016-11-26T11:04:30Z

Published version:

DOI:10.1016/j.oooo.2012.04.025

Terms of use:

Open Access

Anyone can freely access the full text of works made available as "Open Access". Works made available under a Creative Commons license can be used according to the terms and conditions of said license. Use of all other works requires consent of the right holder (author or publisher) if not exempted from copyright protection by the applicable law.

(Article begins on next page)

UNIVERSITÀ DEGLI STUDI DI TORINO

This is an author version of the contribution published on:

Piancino M.G., Frongia G., Dalessandri D., Bracco P., Ramieri G.
Reverse cycle chewing before and after orthodontic-surgical correction in
class III patients.

ORAL SURGERY, ORAL MEDICINE, ORAL PATHOLOGY, ORAL
RADIOLOGY AND ENDODONTICS (2013) 115

DOI: 10.1016/j.oooo.2012.04.025

The definitive version is available at:

<http://linkinghub.elsevier.com/retrieve/pii/S2212440312003823>

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

Piaincino Maria Grazia, Frongia Gianluigi, Dalessandri Domenico, Bracco Pietro, Ramieri Guglielmo

Department of Orthodontics and Gnathology-Masticatory Function, University of Turin, Turin, Italy

Corresponding author:

Maria Grazia Piaincino, Department of Orthodontics and Gnathology, University of Turin Dental School, Via Nizza 230, 10126 Torino, Italy

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.

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.

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 and 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, 6, 7 and 8} although some recent articles report improvement in functional parameters.⁹

The changes occurring in dentition¹⁰ 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 disknetic movements characterized by altered muscular activation¹¹ 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.

MATERIAL AND METHODS

Twenty skeletal class III adult patients (11 males and 9 females, 22.7 ± 3.0 years old [mean $\pm$ 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 III¹⁴; 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 $\pm$ 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).

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 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

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 (Fig. 2 and Fig. 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, 16, 17 and 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, 21 and 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, 24 and 25} The cycles are disknetic 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 orthognathic 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.

REFERENCES

1. P. Bracco, G. Anastasi, M.G. Piancino, G. Frongia, D. Milardi, A. Favaro, P. Bramanti
Hemispheric prevalence during chewing in normal right-handed and left-handed subjects: a functional magnetic resonance imaging preliminary study
Cranio, 28 (2010), pp. 114–121
2. A. Lewin
Electrognathographics: Atlas of Diagnostic Procedures and Interpretation, Quintessence, Berlin (1985), pp. 82–85
3. R.J. Wilding, A. Lewin
The determination of optimal human jaw movements based on their association with chewing performance
Arch Oral Biol, 39 (1994), pp. 333–343
4. W.R. Proffit, R.P. White Jr, M.D. Sarver
Contemporary Treatment of Dentofacial Deformity, Elsevier Health Sciences, St. Louis, MO (2002), pp. 2–3
5. P. Astrand
Chewing efficiency before and after surgical correction of developmental deformities of the jaws
Sven Tandlak Tidskr, 67 (1974), pp. 135–145
6. Y. Shiratsuchi, K. Kouno, H. Tashiro
Evaluation of masticatory function following orthognathic surgical correction of mandibular prognathism
J Craniomaxillofac Surg, 19 (1991), pp. 299–303
7. T. Kobayashi, K. Honma, T. Nakajima, K. Hanada
Masticatory function in patients with mandibular prognathism before and after orthognathic surgery
J Oral Maxillofac Surg, 51 (1993), pp. 997–1001
8. H.M. Zarrinkelk, G.S. Throckmorton, E. Ellis 3rd, D.P. Sinn
A longitudinal study of changes in masticatory performance of patients undergoing orthognathic surgery
J Oral Maxillofac Surg, 53 (1995), pp. 777–782
9. G. Ramieri, M.G. Piancino, G. Frongia, G. Gerbino, P.A. Fontana, C. Debernardi, P. Bracco
Clinical and instrumental evaluation of the temporomandibular joint before and after surgical correction of asymptomatic skeletal class III patients
J Craniofac Surg, 22 (2011), pp. 527–531
10. M.G. Piancino, F. Talpone, P. Dalmaso, C. Debernardi, A. Lewin, P. Bracco
Reverse-sequencing chewing patterns before and after treatment of children with a unilateral posterior crossbite
Eur J Orthod, 28 (2006), pp. 480–484
11. M.G. Piancino, D. Farina, F. Talpone, A. Merlo, P. Bracco
Muscular activation during reverse and non-reverse chewing cycles in unilateral posterior crossbite
Eur J Oral Sci, 117 (2009), pp. 122–128
12. B. Jankelson
Measurement accuracy of the mandibular kinesiograph—a computerized study
J Prosthet Dent, 44 (1980), pp. 656–666

- 13.Y. Ben-Bassat, A. Yaffe, I. Brin, J. Freeman, Y. Ehrlich
Functional and morphological-occlusal aspects in children treated for unilateral posterior cross-bite
Eur J Orthod, 15 (1993), pp. 57–63
- 14.P. Bracco, V. Vercellino
Classificazione basale di 150 soggetti disgnatici secondo ricketts, Steiner e Cervera
Minerva Stomatol, 1 (1980), pp. 1–38
- 15.H. Takeda, Y. Nakamura, H. Handa, H. Ishii, Y. Hamada, K. Seto
Examination of masticatory movement and rhythm before and after surgical orthodontics in skeletal class III patients with unilateral posterior cross-bite
J Oral Maxillofac Surg, 67 (2009), pp. 1844–1849
- 16.K. Yashiro, K. Takada
Post-operative optimization of gum-chewing kinematics in a prognathic patient
Orthod Craniofac Res, 7 (2004), pp. 47–54
- 17.K. Yashiro, M. Takagi, K. Takada
Smoothness of chewing jaw movements in adults with mandibular prognathism
J Oral Rehabil, 39 (2012), pp. 100–110
- 18.T. Kobayashi, K. Honma, S. Shingaki, T. Nakajima
Changes in masticatory function after orthognathic treatment in patients with mandibular prognathism
Br J Oral Maxillofac Surg, 39 (2001), pp. 260–265
- 19.M.G. Piancino, P. Bracco, T. Vallelonga, A. Merlo, D. Farina
Effect of bolus hardness on the chewing pattern and activation of masticatory muscles in subjects with normal dental occlusion
J Electromyogr Kinesiol, 18 (2008), pp. 931–937
- 20.C. Martin, J.A. Alarcon, J.C. Palma
Kinesiographic study of the mandible in young patients with unilateral posterior crossbite
Am J Orthod Dentofacial Orthop, 118 (2000), pp. 541–548
- 21.B. Troelstrup, E. Moller
Electromyography of the temporalis and masseter muscles in children with unilateral cross-bite
Scand J Dent Res, 78 (1970), pp. 425–430
- 22.P. Pirttiniemi, T. Kantomaa, P. Lahtela
Relationship between craniofacial and condyle path asymmetry in unilateral crossbite patients
Eur J Orthod, 12 (1990), pp. 408–413
- 23.J. Ahlgren
Pattern of chewing and malocclusion of teeth: A clinical study
Acta Odontol Scand, 25 (1967), pp. 3–13
- 24.I. Brin, Y. Ben Bassat, Y. Blustein, Y. Ehrlich, N. Hochman, Y. Marmary, A. Yaffe
Skeletal and functional effects of treatment for unilateral posterior crossbite
Am J Orthod Dentofacial Orthop, 109 (1996), pp. 173–179
- 25.G.S. Throckmorton, P.H. Buschang, H. Hayasaki, A.S. Pinto
Changes in the masticatory cycle following treatment of posterior unilateral crossbite in children

Am J Orthod Dentofacial Orthop, 120 (2001), pp. 521–529