



## Evaluation of recovery in lip closing pressure and occlusal force and contact area after orthognathic surgery



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### ARTICLE INFO

#### Article history:

Paper received 17 October 2013

Accepted 13 January 2014

#### Keywords:

Lip closing force  
Occlusal contact area  
Occlusal force  
Mandibular prognathism  
Orthognathic surgery

### ABSTRACT

**Purpose:** The purpose of this study was to evaluate the relationship between lip closing force, occlusal contact area and occlusal force after orthognathic surgery in skeletal Class III patients.

**Subjects and methods:** The subjects consisted of 54 patients (28 female and 26 male) diagnosed with mandibular prognathism who underwent sagittal split ramus osteotomy with and without Le Fort I osteotomy. Maximum and minimum lip closing forces, occlusal contact area and occlusal force were measured pre-operatively, 6 months and 1 year post-operative.

**Results:** Maximum and minimum lip closing forces, occlusal contact area and occlusal force increased with time after surgery, however a significant increase was not found in the occlusal contact area in women. In increased ratio (6 months/pre-operative and 1 year/pre-operative), the maximum lip closing force was significantly correlated with the occlusal contact area ( $P < 0.0001$ ).

**Conclusions:** This study suggested that orthognathic surgery could improve the occlusal force, contact area and lip closing force, and an increase ratio in maximum lip closing force was associated with an increased ratio in occlusal contact area.

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## 1. Introduction

Orthognathic surgery can alter not only morphological aspects, but also functional aspects. Lip-closing function can be achieved by various types and various amounts of lip-closing movements, depending on the physiological behaviour required. Lip closing movements are not simple tasks like eye blinking, but complex and well-organised tasks that can be performed by the orbicularis oris muscle, with additional facial muscles that have muscle fibres in various directions, around the orifice of the mouth. Orbicularis oris muscle is a sphincter muscle composed of two parts in the upper and lower lips (Standring, 2005).

Most dental professionals accept the theory of Tomes (Tomes, 1973), who asserted that opposing forces or pressure from the lips and cheeks on one side and the tongue on the other, determine the position of the teeth (Mitchell and Williamson, 1978; Posen, 1976). In several studies, it was suggested that lip closing force

could be associated with the skeletal and occlusion patterns (Gould and Piston, 1962; Posen, 1972, 1976; Ruan et al., 2007).

One of the major objectives of orthognathic surgery is to improve bite force. Many studies have been reported on occlusal force after orthognathic surgery (Harada et al., 2000; Iwase et al., 1998; Kim and Oh, 1997; Nagai et al., 2001; Ohkura et al., 2001; Proffit et al., 1989; Throckmorton et al., 1995, 1996). Proffit et al. (1989) have stated that bite force is affected by two factors, the amount of force generated by the masticatory muscles and the length of their moment arms. Throckmorton et al. (1995) proposed that surgically altered geometry might influence the maximum bite force directly by altering the mechanical advantage of individual muscles. Furthermore, we found that there was a strongly positive correlation between bite force and occlusal contact in our previous study (Ueki et al., 2007).

Although it was suggested that lip pressure and bite force were related to the skeletal and occlusion patterns, there is no study that has examined the relationship between lip pressure and bite force before and after orthognathic surgery.

The purpose of this study was to evaluate the relationship between lip closing force, occlusal contact area and occlusal force after orthognathic surgery for skeletal Class III patients.

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## 2. Materials and methods

### 2.1. Patients

The subjects consisted of 26 men (average age,  $25.4 \pm 7.9$  years) and 28 women (average age,  $33.4 \pm 13.2$  years) with a Class III malocclusion. All cases were diagnosed as skeletal Class III including mandibular prognathism and/or maxillary retrognathism on the basis of a lateral cephalogram analysis and the patients underwent orthognathic surgery.

To allow comparison with the lip closing force in normal subjects, a control group consisting of 20 women (average age,  $29.5 \pm 4.9$  years) and 20 men (average age,  $29.5 \pm 3.9$  years) with normal occlusion without dento-alveolar deformity was selected.

In comparison with normal subjects in occlusal force and occlusal contact area, the control group consisted of 35 volunteers (18 men and 17 women; mean age 24.2 years; range, 22–34 years). All of them were skeletal and dental Class I relationships with no sign of temporomandibular joint involvement.

Although this study was a retrospective study, informed consent was obtained from the patients and the study was approved by Kanazawa University Hospital.

### 2.2. Measurement of lip closing force

Maximum and minimum lip closing forces were measured with Lip De Cum LDC-110R<sup>®</sup> (Cosmos instruments Co. LTD, Tokyo, Japan) (Fig. 1) for the control groups and subject groups both preoperatively and at 6 months and 1 year post-operative. This device consists of a sensor with a lip adaptor and digital display (Noro et al., 2002).

The Lip Closure Strength (force) Indicator (Lip De Cum<sup>®</sup>) was set up with a Lip holder (Ducklings<sup>®</sup>) mounted to the sensor, and the subject was instructed to bite the holder between the upper and lower lips. Then, Lip Closure Strength (force) of the subject was measured while the subject was sitting upright (with the FH plane parallel to the floor plane) and was instructed to close the upper and lower lips with utmost strength but never allowing the upper and lower teeth to touch. This device contains 4 strain gauges at the sensor and converts the measurement value into load value (N). During a measurement lasting for 30 s, the shape of the wave is shown on the display of a personal computer connected to the Lip De Cum<sup>®</sup>. In the wave, the largest and smallest values were defined as the maximum and minimum values, respectively (Fig. 2).



Fig. 1. Lip Closure Strength (force) Indicator (Lip De Cum<sup>®</sup>) with a Lip holder (Ducklings<sup>®</sup>).

### 2.3. Measurement of occlusal force

Dental Prescale and Occluzar were used in this study. This device consisted of the pressure-sensitive sheet (Dental Prescale; Fuji Photo Film Co, Tokyo, Japan) (Fig. 3) analysing apparatus (Dental Occlusion Pressuregraph FPD-705; Fuji Photo Film Co) that was connected to a personal computer. The patients were seated with their head in an unsupported natural position, looking forward. The pressure-sensitive sheet was placed between maxillary and mandibular teeth and the patients were instructed to bite as forcefully as possible for about 3 s. The sheet was read and analysed by a Dental Occlusion Pressuregraph, then the results were inputted into the computer and visualised on the display. The patients were measured just before the operation and at 6 months and 1 year after the operation.

Increase ratio was determined as value after 6 months/pre-operative value and value after 1 year/pre-operative value in all measurements (maximum lip closing force, minimum lip closing force, occlusal force and occlusal contact area).

#### 2.3.1. Statistical analysis

Data were statistically analysed with Dr. SPSSII (SPSS Japan Inc., Tokyo, Japan). The data for each period within the group were analysed by *t*-test. In increase ratio, correlation coefficient among all measurements was calculated. Then, simple regression analysis was performed between measurements with the highest correlation coefficient. The differences were considered significant at  $P < 0.05$ .

## 3. Results

Of the 26 men, 17 with mandibular prognathism underwent Le Fort I osteotomy with bilateral sagittal split ramus osteotomy (SSRO) and 9 underwent bilateral SSRO alone. Of 28 women, 11 with mandibular prognathism underwent Le Fort I osteotomy with bilateral SSRO and 17 underwent bilateral SSRO. The mean setback amount was  $6.5 \pm 3.0$  mm on the right side and  $6.0 \pm 3.3$  mm on the left side in men, and  $6.5 \pm 3.4$  mm on the right side and  $7.1 \pm 3.3$  mm on the left side in women. There were no significant differences in setback amount between men and women.

In the maximum lip closing force in men, the value after 6 months was significantly larger than the preoperative value ( $P = 0.0192$ ) and the value after 1 year was still larger than the

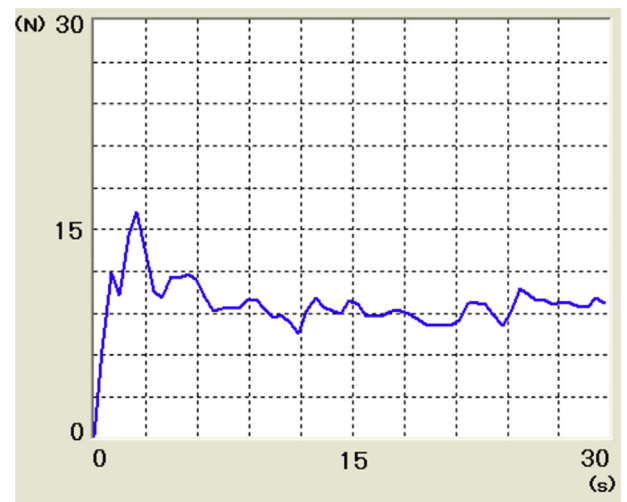


Fig. 2. The recorded wave of the lip closing force for 30 s.

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