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Two-year follow-up of changes in bite force and occlusal contact area after intraoral vertical ramus osteotomy with and without Le Fort I osteotomy

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Abstract. This study was performed to examine the longitudinal changes in bite force and occlusal contact area after mandibular setback surgery via intraoral vertical ramus osteotomy (IVRO). Patients with mandibular prognathism who underwent IVRO (surgical group: 39 men and 39 women) were compared with subjects with class I skeletal and dental relationships (control group; 32 men and 35 women). The surgical group was divided into two subgroups: 1-jaw surgery ($n = 30$) and 2-jaw surgery ($n = 48$). Bite force and contact area were measured in maximum intercuspation with the Dental Prescale System before treatment, within 1 month before surgery, and at 1, 3, 6, 9, 12, and 24 months postsurgery. A linear mixed model was used to investigate the time-dependent changes and associated factors. Bite force and contact area decreased during presurgical orthodontic treatment, were minimal at 1 month postsurgery, and increased gradually thereafter. The 1-jaw and 2-jaw subgroups showed no significant differences in bite force. The time-dependent changes in bite force were significantly different according to the contact area ($P < 0.05$). The results of this study suggest that bite force and occlusal contact area gradually increase throughout the postsurgical evaluation period. Increasing the occlusal contact area may be essential for improving bite force after surgery.

Keywords: orthognathic surgery; IVRO; bite force; occlusal contact area..

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Patients with skeletal class III malocclusions commonly show anterior crossbite, dental compensation, and class III canine and molar relationships, with resulting difficulties in mastication. Depending on the severity, orthodontic camouflage treatment can be limited and orthognathic surgery is performed to enhance facial aesthetics and function.[1,2] Most studies have focused on postsurgical morphological changes, not functional changes, because it is difficult to investigate quantitative changes in masticatory function after surgery. With regard to functional parameters, the measurement of bite force and occlusal contact area with thin pressure-sensitive sheets has been used widely and is reported to

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Table 1. Demographic features of the study subjects.

Demographic variables	Control group	Surgical group*		*P*-value
		1-Jaw	2-Jaw	
Sex, male/female	32/35	13/17	26/22	0.5625
Age, years	25.6 ± 5.1	24.2 ± 6.6	23.1 ± 4.42	0.0554

* 1-Jaw indicates only IVRO (intraoral vertical ramus osteotomy); 2-jaw indicates IVRO with additional Le Fort I osteotomy.

represent the occlusal condition quite accurately.[1,3–12]

According to previous studies, patients requiring mandibular setback surgery have significantly lower bite forces and smaller contact areas than individuals with normal occlusion[1,4,6,13–15]; these parameters decrease further during presurgical orthodontic treatment, becoming minimal immediately after surgery and increasing gradually thereafter. However, they have been found not to normalize even at 2 years postsurgery.[1,6]

Most previous studies have focused on the changes after sagittal split osteotomy (SSRO). Intraoral vertical ramus osteotomy (IVRO) is another frequently used method for mandibular setback. SSRO has been performed more often because of the ability to apply rigid internal fixation, while with IVRO, the proximal and distal mandibular segments are not rigidly stabilized but are overlapped to move freely and heal accordingly.[16] Therefore, IVRO requires a longer duration of maxillomandibular fixation (MMF) than SSRO and the use of class II intermaxillary elastics to prevent backward mandibular movement.[17,18] These differences may affect postsurgical changes in bite force and contact area.

Ueki et al.[5] investigated the changes in bite force and contact area after IVRO as well as SSRO in female patients with class III malocclusions. They found that the parameters returned to preoperative levels, not initial levels, at between 3 and 6 months after surgery. However, these patients with class III malocclusion were not compared to patients with normal occlusion. In addition, the study included only women; given that bite force differs significantly between men and women,[1,7,19] the functional changes after IVRO should be evaluated in men as well.

There are few studies investigating the factors that affect changes in bite force and contact area following surgery. Although Iwase et al.[1] reported that bite force and contact area showed strong correlations in both the control and patient groups at 1 year postsurgery, other factors such as sex, age, and the initial bite force were not considered. According to Kim and Oh,[17] bite force was positively correlated with the surgical change in mandibular plane angle and mandibular body length, and the recovery of bite force was significantly affected by the type of operation and duration of MMF. However, because they measured the bite force only at the opposing first molars using a bite force transducer, these findings may be different from those of the total dentition.

Therefore, the aim of the present study was to examine the changes in bite force and occlusal contact area up to 2 years after IVRO and to investigate the factors associated with the time-dependent changes.

Materials and methods

Subjects

This prospective study included a surgical group ($n = 78$), which was divided into two subgroups (1-jaw surgery and 2-jaw surgery), and a control group ($n = 67$) matched by vertical cephalometric relationships (Table 1). For the surgical group, 149 consecutively treated patients were selected among 192 who visited the study hospital between March 2008 and August 2009; these patients were diagnosed with skeletal class III malocclusions and treatment was planned for mandibular setback surgery. The exclusion criteria included: missing tooth/teeth excluding the third molars, temporomandibular joint disorders, systemic diseases, cleft lip/palate, and craniofacial syndromes. Due to incomplete follow-up data, 71 patients were excluded from the investigation and 78 patients were selected for the final surgical group (39 men and 39 women; mean age 23.8 years, range 18.5–44.1 years). These subjects underwent pre- and postsurgical orthodontic treatment using fixed appliances and mandibular setback via IVRO, either with Le Fort I osteotomy (2-jaw surgery subgroup, $n = 48$) or without Le Fort I osteotomy (1-jaw surgery subgroup, $n = 30$). All treatments including orthognathic surgery were performed in the same hospital. A number of patients (16 men and 12 women) in the surgical group underwent maxillary premolar extractions for decompensation. However, because bite force and occlusal contact area were not significantly different between patients treated with and without premolar extraction,[7] the surgical group was not divided according to the extraction regimes.

The control group (32 men and 35 women; mean age 25.6 years, range 19.3–39.1 years) was carefully matched to the experimental group by age, sex, and mandibular plane angle (sella–nasion to gonion–menton angle) from a pool of orthodontic patients with class I skeletal and dental relationships and less than 2 mm of arch length tooth size discrepancy. The control subjects were selected among individuals who had pre-treatment records including bite force and occlusal contact area. The same exclusion criteria were applied as for the surgical group.

All surgeries were performed by a single surgeon, while three orthodontists, each with over 10 years of clinical experience, randomly participated in the orthodontic aspect of treatment. No damage to the nerves or temporomandibular joints was observed after the surgeries. The mandibular segments were not fixed during surgery, and the duration of MMF was approximately 2 weeks. Thereafter, all patients received sequential elastic traction to maintain the ideal occlusion and intensive postoperative physiotherapy. The average duration of postsurgical orthodontic treatment was approximately 8.3 months (range 5.0–14.5 months). During the retention period, fixed lingual retainers were bonded on both arches.

Measurements

The Dental Prescale System (FujiFilm Corp., Tokyo, Japan) was used to measure maximum bite force and occlusal contact area. The system (Fig. 1) consists of a horseshoe-shaped, pressure-sensitive sheet (50H, type R-L) and image scanner (Occluzer FPD-707). The system has a small range of error,[7–9] and is not affected by intraoral humidity, velocity and duration of pressure, or temperature.[5] Data on reproducibility and the method of calibration have been reported previously.[3,4] This system has already been used for analyzing occlusion with dentures,[10] dental implants,[11] and orthognathic surgery,[1,3–6] and its accuracy and reliability have been confirmed.[12]

A pressure-sensitive sheet of the proper size was selected to fit the dental arch of each subject. The subject practiced clenching in intercuspal position before the measurement was taken and was then