

## Systematic Review Orthognathic Surgery

# Changes in bite force after orthognathic surgical correction of mandibular prognathism: a systematic review

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**Abstract.** Patients requesting treatment for mandibular prognathism seek functional and aesthetic improvements. Improvements in bite force and efficiency are generally used as measures of better function. It is unclear what effect the surgical correction of mandibular prognathism will have on the patient's occlusal forces. The literature was searched using medical subject heading (MeSH) and key word terms 'bite force', 'osteotomy', 'orthognathic surgery', and 'prognathism'. A total of 17 articles were included in this review. These included a total of 697 patients, who ranged in age from 15 to 44 years. Male patients outnumbered female patients in only one study. Five hundred and thirty-two patients underwent bilateral sagittal split osteotomy, 108 patients underwent intraoral vertical ramus osteotomy, and 24 patients underwent extraoral vertical ramus osteotomy (approach unspecified). In general, masticatory efficiency at 3 months after surgery was greater than that found pre-surgically; the increase was significant at 6 months after surgery. The occlusal contact area and points tended to increase from 3 months after surgery, and there was a significant increase at 12 months after surgery. Occlusal forces, although improved, will be lower in corrected prognathic patients than in normognathic patients even at 2 years after surgery.

**Keywords:** Mandible; Mental foramen; Multi-detector computed tomography; Accessory mental foramen; Lingual vascular canal.

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Orthognathic surgery in combination with pre-surgical and post-surgical orthodontic treatment is performed when the severity of malocclusion precludes orthodontic camouflage alone. In the East Asia region, the most common deformity is that of mandibular prognathism. The most frequent procedures for mandibular setback

are the bilateral sagittal split ramus osteotomy (BSSO) and intraoral vertical ramus osteotomy (IVRO). The extraoral vertical ramus osteotomy (EVRO) is less often utilized. The area of bony contact between the proximal and distal mandibular segments is larger in BSSO than IVRO or EVRO. Rigid internal fixation is almost

always used with BSSO, whereas in IVRO and EVRO the overlapping segments are not rigidly stabilized. Intermaxillary fixation (IMF) is consequently of a shorter duration or is not required with BSSO, whereas with IVRO and EVRO, patients are typically placed in IMF for 6–8 weeks. A concomitant Le Fort I osteotomy (LFI)

is commonly employed in the treatment of prognathic patients, who may also exhibit maxillary deformities such as maxillary retrognathia or vertical maxillary excess.

Patients requesting treatment for mandibular prognathism seek functional rehabilitation along with improvement in aesthetics.<sup>1-6</sup> These patients tend to have poorer masticatory function than normal individuals.<sup>7-17</sup> A major contributing factor is poor occlusion, with anterior and posterior cross-bite and poor intercuspation.<sup>12</sup> Another reason could be the weaker capacity of the jaw musculature, which has been shown to be smaller in dimension and lower in electromyographic activity.<sup>8,11,12,18-23</sup>

The post-surgical recovery of masticatory function is difficult to assess and quantify objectively. Measurements of maximum bite force, occlusal contacts, masticatory efficiency, electromyographic activity and dimensions of masticatory muscles, mandibular range of motion, and the shape and timing of the chewing cycle have been used. Of the many varied methods, maximum bite force is widely recognized as an effective indicator of both the state of the dentition and capacity of the masticatory muscles.

Improved outcomes are a measure of the success of a procedure. As such, the following questions arise for orthognathic surgery in terms of functional rehabilitation: (1) Is there an improvement in the bite force or masticatory efficiency? (2) In the many studies published, what were the overall improvements and how were the outcomes (bite force and masticatory efficiency) measured? The aim of this study was to answer these questions by performing a systematic review of the literature.

## Methods

This systematic review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement for systematic reviews.<sup>24</sup> Electronic searches of the MEDLINE/PubMed database were

performed to identify relevant human studies published in the English-language literature from 1966 to the present. Initial searches were performed to identify seed articles to suggest appropriate free-text terms and medical subject heading (MeSH) terms. The key words derived were the free-text terms 'bite force', 'masticatory efficiency', 'osteotomy', 'orthognathic surgery', and 'prognathism', and the MeSH term 'prognathism/surgery'. These were used in combinations for the final search strategy (Table 1).

The inclusion criteria for the search were as follows: (1) clinical studies measuring bite force, (2) adult patients with mandibular prognathism (skeletal class III malocclusion) who were treated by orthognathic surgical procedures such as LFI, BSSO, IVRO, and EVRO.

Studies were excluded if they involved patients with craniofacial syndromes and if the time interval between surgery and post-surgical bite force measurement was not specified. Case reports and review articles were also excluded.

## Results

This initial screening yielded 127 articles concerning (1) bite force, (2) masticatory efficiency, (3) orthognathic surgery, and (4) mandibular prognathism. There was overlap of articles between the bite force and masticatory efficiency search terms; after the elimination of duplicates as well as the assessment of relevance, no new articles were selected. After the initial screening, 22 articles were identified as potentially relevant. Subsequently, the full texts of these articles were obtained and their references were searched manually. This manual search added two potentially relevant articles. The authors read the 24 articles, and agreement on inclusion was reached by discussion (Fig. 1).

After this screening, seven more articles were excluded. Data were extracted from the 17 articles that remained eligible for inclusion in this literature review (Table 2).

The articles were published between 1994 and 2014. Of the 17 articles, 16 reported longitudinal studies and one reported a cross-sectional study.

The total number of patients included in the studies was 697, and they ranged in age from 15 to 44 years. Male patients outnumbered female patients in only one study.<sup>25</sup> The number of male patients ( $n = 188$ ) ranged from 7 to 39, and the number of female patients ( $n = 462$ ) ranged from 11 to 77.

All studies addressed mandibular prognathism or skeletal class III malocclusion. BSSO alone was performed in 12 studies and in combination with LFI in four studies. Two studies reported that BSSO was performed and no specific maxillary procedures were consistently performed in combination. IVRO alone was performed in two studies, and in combination with LFI in two studies. One study reported that VRO was performed, although there was nothing mentioned on the surgical approach used (extraoral or intraoral); VRO alone and in combination with LFI were performed.

Amongst the different surgical groups, the mean age of the patients ranged from 19 to 25.5 years. Five hundred and thirty-two patients underwent BSSO, 108 patients underwent IVRO, and 24 patients underwent EVRO (approach unspecified). The amount of movement of bony segments was reported in seven studies and not reported in 10 studies. Rigid fixation of the segments with no IMF was used in four studies. Rigid fixation followed by post-surgical IMF was used in five studies. Non-rigid fixation of the segments followed by IMF was used in four studies. Rigid fixation and non-rigid fixation, both with IMF, were used in two studies. The method of fixation was not reported in three studies.

With regards to the sets of records, two studies took two sets, one study took three sets, two studies took four sets, five studies took five sets, three studies took six sets, one study took seven sets, two studies took

Table 1. Search strategy.

Search entry	Articles displayed	After elimination of duplicates	Potentially relevant articles
Bite force AND osteotomy	86	86	18
Bite force AND orthognathic surgery	55	29	3
Bite force AND prognathism	36	12	1
Bite force AND (prognathism/surgery [MeSH Terms])	23	0	0
Masticatory efficiency AND osteotomy	10	0	0
Masticatory efficiency AND orthognathic surgery	13	0	0
Masticatory efficiency AND prognathism	14	2	0
Masticatory efficiency AND (prognathism/surgery [MeSH Terms])	0	0	0
Total	-	129	22

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