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Clinical Paper
Orthognathic Surgery

Correction of facial asymmetry associated with vertical maxillary excess and mandibular prognathism by combined orthognathic surgery and guiding templates and splints fabricated by rapid prototyping technique

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Abstract. The facial asymmetry associated with vertical maxillary excess and mandibular prognathism is one of the more complicated types in the field of oral and maxillofacial surgery. The purpose of this study was to investigate the efficacy of combined orthognathic surgeries, together with guiding templates and splints fabricated by rapid prototyping technique, for the correction of facial asymmetry. Fourteen patients with facial asymmetry associated with vertical maxillary excess and mandibular prognathism were included. A maxillary Le Fort I osteotomy, a sagittal split ramus osteotomy on the shorter side of the face, and an intraoral vertical ramus osteotomy on the longer side of the face were performed with the aid of guiding templates and splints fabricated by rapid prototyping technique. Parameters reflecting maxillary canting, ramal inclination, mandibular deviation, and chin inclination were measured before surgery, 7 days after surgery, and 1 year after surgery, and compared. Significant differences in these parameters were found between the two sides preoperatively, whereas no differences were observed postoperatively. Facial asymmetry was corrected in all

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patients with satisfactory outcomes. In conclusion, combined orthognathic surgery and guiding templates and splints can offer improvements in accuracy, complexity, and duration over traditional procedures for the correction of facial asymmetry associated with vertical maxillary excess and mandibular prognathism.

Key words: facial asymmetry; mandibular prognathism; orthognathic surgery; rapid prototyping; correction; maxillary canting.

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Facial asymmetries encompass a multitude of diverse and potentially complex abnormalities that may have numerous causes. Facial asymmetry associated with vertical maxillary excess and mandibular prognathism is one of the more complicated types in the field of oral and maxillofacial surgery. This type of asymmetry may involve canting of the occlusal level, midline shift, and class III malocclusion. The correction of facial asymmetry in cases with vertical maxillary excess and mandibular prognathism presents a challenge for the oral and maxillofacial surgeon because it requires three-dimensional (3D) consideration — in the vertical, sagittal, and frontal planes. The usual method for correcting facial asymmetry involves orthognathic surgeries, including Le Fort I osteotomy, sagittal split ramus osteotomy (SSRO), and intraoral vertical ramus osteotomy (IVRO), as well as genioplasty. Although all procedures result in improvements in the facial asymmetry to varying degrees, the majority of published studies have illustrated the difficulty in achieving absolute symmetry.[1–3]

In the patient with facial asymmetry associated with vertical maxillary excess and mandibular prognathism, the mandibular asymmetry accompanying the excessive growth of the maxilla usually involves a class III malocclusion and a much lower border of the mandible on the longer side of the face than on the shorter side of the face. Both SSRO and IVRO have been used widely to set back the mandible.[4,5] When an SSRO is performed on the longer side of the face, the midline shift and malocclusion can be corrected by repositioning the distal segment. However, the proximal segment is supposed to be kept in its original place, which leaves the inferior border of the mandible unchanged. Thus an additional inferior border ostectomy of the mandible may be needed on the longer side of the face (Fig. 1A). The IVRO, however, is different from SSRO. With this technique the inferior border of the mandible can be moved superiorly to level with the opposite side (Fig. 1B). Our experience suggests that a combined SSRO and IVRO is an appropriate surgical combination for the correction of mandibular asymmetry in patients with vertical maxillary excess.

Orthognathic surgical planning still relies heavily on model surgery and the use of interocclusal splints. However, this approach has several limitations, such as imprecise surgical transfer of the surgical plans and insufficient control of the maxillary position because of the mobility of the mandible.[6] Recently, orthognathic surgery has been improved by the introduction of 3D guiding templates and splints using a rapid prototyping technique.[7,8] With the help of guiding templates and splints obtained by computer-aided design/computer-aided manufacturing (CAD/CAM), the surgeon can transfer the predesigned maxillary plan precisely to the real surgery according to the cranial base plane.[9]

The purpose of this study was to investigate the efficacy of a combination of orthognathic surgeries, together with guiding templates and splints fabricated by rapid prototyping technique, for the correction of facial asymmetry associated with vertical maxillary excess and mandibular prognathism.

Materials and methods

From March 2010 to March 2013, 14 patients diagnosed with facial asymmetry associated with vertical maxillary excess and mandibular prognathism underwent bimaxillary osteotomy surgery with CAD/CAM surgical splints in the department of oral and maxillofacial surgery of the study hospital in Chengdu, China. Inclusion criteria were the following: (1) clinically and radiologically verified facial asymmetry related to unilateral vertical maxillary excess and (2) mandibular prognathism. If the facial asymmetry was found to be related to a short mandibular ramus, the patient was excluded. Of the 14 patients included, five were male and nine were female; they ranged in age from 20 to 29 years (average age 24 years).

All patients were treated according to the following protocol developed in the department of maxillofacial surgery of the study hospital: routine radiological examinations (panoramic, postero-anterior, and lateral X-rays and cone beam computed tomography (CBCT)), preoperative orthodontic treatment, combined two-jaw surgery with CAD/CAM templates, and postoperative orthodontic treatment.

Virtual surgery and CAD/CAM surgical templates and splints

All patients underwent a CBCT examination. The images, obtained in Digital Imaging and Communications in Medicine (DICOM) format, were processed using Mimics software version 10.01 (Materialise, Leuven, Belgium). The 3D bone segments corresponding to a Le Fort I osteotomy, an IVRO on the affected side, and an SSRO on the other side, and genioplasty if necessary, were segmented.

Two sets of templates were used to determine the maxillary position. The first set of templates consisted of the two bridges, the first splint, and two other small pieces. The bridges were used to connect the first splint and the small pieces via the holes in these. The first set of templates was used to predefine the original maxillary position before osteotomy (Fig. 2A). After that, the maxillary osteotomized segment was repositioned to level the occlusal plane, and the second set of bridges was used to make sure that the maxilla reached the predesigned position (Fig. 2A). With the help of these surgical templates, the maxillary position was easily controlled, independent of the mandible.

The mandibular symmetry at the inferior border resulting from bilateral SSRO was also simulated and compared with that from combined SSRO and IVRO. The results showed that the combined effect of SSRO and IVRO had a better symmetry at the inferior border than bilateral SSRO. Next, the osteotomized mandible was adjusted to achieve optimal dental intercuspation with the final splint (Fig. 2B). If a levelling genioplasty was required, another template was designed and manufactured. All the templates and splints were sent by the manufacturer to the surgeon and sterilized by low-temperature plasma disinfection (Fig. 3).

Surgical procedures

Two-jaw orthognathic surgery was performed according to the preoperative