

Advances in the surgery-first orthognathic approach for the treatment of patients with malocclusion

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Abstract: Combined orthognathic and maxillofacial treatment is the main approach to correct severe dentofacial deformities, which includes conventional orthognathic surgery (COS) and surgery first approach (SFA). The COS model consists of 3 different treatment phases: preoperative orthodontic debridement, orthopaedic surgery and postoperative orthodontic occlusal adjustment. In order to prevent the deterioration of transient facial deformities caused by preoperative orthodontics and to shorten the overall treatment time as well as to improve patient satisfaction, the surgical first approach (SFA) has been proposed, in which the patient undergoes orthognathic surgery without preoperative orthodontics, or with as little preoperative orthodontics as possible, and then undergoes postoperative orthognathic occlusal refinement. SFA has obvious advantages over traditional combined orthodontic and orthognathic treatment, but at the same time, the selection of indications and contraindications is more stringent. SFA, as an alternative to traditional orthodontic orthognathic treatment, has been one of the hottest research topics in recent years, with increased surgical design and complexity for the operator. This article reviews the advantages, disadvantages, indications, and contraindications of surgical priority orthognathic modalities and orthognathic treatment in traditional modalities, in the hope of providing clinicians with some reference value when choosing treatment modalities.

Keywords: orthognathic surgery, surgical priority, traditional model

1. Limitations of COS

Bony Class III malocclusion is a common maxillofacial deformity characterised by the presence of a significant misalignment of the mandible and maxilla, which is usually manifested as an overgrowth of the mandible or an overshrinking of the maxilla, resulting in a forward movement of the mandible, which is misaligned with the maxilla, resulting in an abnormal occlusion and jaw deformity. This deformity is usually accompanied by problems such as facial dysmorphia, chewing and speech dysfunction. For those with severe jaw deformities, the facial shape cannot be effectively improved by orthodontic masking treatment alone, especially for adult patients whose growth and development have been completed and whose jaws are severely malaligned, orthognathic surgery is currently the only effective treatment ^[1].

Conventional orthodontics is the mainstay of treatment for bony Class III malocclusion, but its limitations can increase psychological pressure on the patient as well as decrease cooperation. The most important reasons for this include the fact that preoperative orthodontics can exacerbate anterior occlusion when tooth substitution is removed, worsening of the lateral facial appearance, and lengthening of the total treatment time with preoperative orthodontics ^[2].

Different studies have shown that the average preoperative orthodontic time ranges from 15.4 to 25 months ^[3], and can be as long as 47 months. This process may also increase the chances of gingival recession, gingival hyperplasia, dental caries, root resorption, occlusal dysfunction, masticatory and speech discomfort, which directly reduces the quality of life and compliance of patients ^[4].

1.1 Time-consuming preoperative orthodontics

The steps of preoperative orthodontics focus on removing substitution by levelling the dentition, adjusting the maxillary and mandibular arch relationships, relieving tooth crowding, and levelling the occlusal plane. Data from various studies show that the total orthodontic treatment time for combined orthognathic and maxillary orthodontic treatment is 27.8 months, including 16.7 months of

preoperative orthodontics, which suggests that preoperative orthodontics accounts for a large part of the treatment process^{[5][6]}. The SFA can shorten the entire treatment time to 1.0 to 1.5 years or even less depending on the complexity of the case^[7]. With the development of socio-economic level, most of the patients who come to the hospital with osseous dentofacial deformities are aesthetically and socially conscious adults who are at an important stage of their lives. It is difficult for them to undergo prolonged orthodontic treatment, so reducing the total treatment time is an important factor in determining whether they will undergo orthognathic surgery and whether they will actively cooperate with the treatment^[8]. The reduction in total treatment time reduces the incidence of psychological problems in addition to the effective avoidance of some common preoperative complications^[3]. Therefore, the long time required for preoperative orthodontic treatment becomes one of the factors that constrain the development of COS.

1.2 Severe preoperative orthodontic facial deterioration

Most of the patients with bony Class III malocclusion are often accompanied by intraoral malocclusion, occlusal disorders, abnormal overlap-coverage relationship, poor oral hygiene and other problems. In addition, intraoral bonding of orthodontic brackets during preoperative orthodontic treatment makes them more prone to dental caries, gingivitis, and periodontal disease, which may even deteriorate the occlusal function of such patients and lead to problems such as an even uglier facial profile. At the same time, various studies have reported that patients with adult bony ankylosed Class III malocclusion have higher requirements for facial aesthetics than other aspects such as occlusal function^[8]. Therefore, oral diseases and facial disfigurement resulting from the preoperative orthodontic process make patients fearful and reduce their acceptance of combined orthodontic-orthognathic treatment, and these factors limit the development of COS while promoting the creation of SFA.

2. Development of the basic concept of the SFA

Due to the challenges faced by the traditional orthognathic treatment, in 2009, Japanese scholar Nagasaka^[2] proposed a new concept of "Surgery-First Approach" for orthognathic treatment for the first time, which was successfully applied to clinical cases. The Surgery-First Approach has been successfully applied to clinical cases. The "Surgery-First Approach" orthognathic treatment is almost never performed, or only receives a short (no more than 2 months) preoperative orthodontic preparation, and priority is given to orthognathic surgery, which is followed by fine occlusal adjustments in conjunction with postoperative orthodontic treatment. It focuses on maximising the early resolution of skeletal deformities and occlusion problems through segmental osteotomies, in which the patient first undergoes surgery to achieve a significant improvement in facial appearance, and then undergoes conventional orthodontic treatment to straighten the teeth and ultimately establish a stable and harmonious occlusion. This significantly shortens the overall cycle of orthodontic treatment and eliminates or reduces the problem of worsening facial deformity during preoperative orthodontics. However, without preoperative orthodontics, the occlusal relationship of the teeth cannot be used as a reference for designing the surgical plan, and dental arch compensation and unstable occlusal relationship affect intraoperative bone movement, so direct orthognathic surgery not only has inherent limitations in predicting the position of the jaws and occlusal relationship after the jaws are moved, but also requires a high degree of precision in surgical operation. In recent years, with the development of computer-assisted technology and the improvement of internal fixation technology, 3D virtual occlusion design and other technologies can better predict the position and occlusal relationship after bone movement, and "surgery first" has entered the vision of modern medicine^[9].

In conclusion, SFA is a combined orthodontic-orthognathic treatment model that requires close collaboration and consultation between orthognathic surgeons and orthodontists. Orthognathic surgery is performed first in order to solve the problem of jaw deformity, which is simplified to a simple dental malocclusion, and the removal of dental substitutions and occlusion adjustments are improved in postoperative orthodontics.

3. Advantages and disadvantages of SFA

3.1 Advantages

In most cases patients who undergo orthognathic surgery do not only aim to straighten their teeth, but their main complaint is often that they wish to correct their jaw deformity in order to obtain a good facial appearance.

The advantages of the "surgery first" approach are: 1. At the initial stage of treatment, the harmonisation of the soft and bony tissues of the maxillofacial region can be achieved more quickly through surgery^[2,10], avoiding the removal of tooth substitutions, which can exacerbate the ugliness of the patient's appearance during the preoperative orthodontic process.

1) Orthognathic surgery induces regional acceleratory phenomenon (RAP): after orthognathic surgery, local alveolar bone remodeling is accelerated and can last for 3 to 4 months, resulting in accelerated orthodontic tooth movement. Liou ^[7] et al. suggested that the overall shortening of the treatment time in the orthognathic model of SFA may be related to the orthognathic surgery after the RAP.

2) The SFA preferentially changes the abnormal jaw position and improves the dynamic balance of the perioral soft tissues, so that when the orthognathic surgery is completed, the direction of tooth movement required for de-substitution is coordinated with the new position of the teeth and muscles against the surrounding bone. This makes postoperative orthodontics more efficient in moving teeth with muscle restrictions removed^[11].

3) It has been found that adult patients with bony Class III malocclusion who are more concerned about their facial appearance have better medical compliance with SFA, as well as higher satisfaction with treatment.

3.2 Disadvantages

SFA, the most talked about alternative to orthognathic treatment in recent years, has had some shortcomings during its development^[12]. Compared with SFA, the traditional model can achieve tooth removal substitution during preoperative orthodontics, make it easier to achieve a relatively stable occlusal relationship and a relatively fixed jaw position during orthognathic surgical design, and achieve more precise movement of the jaw in all directions during surgery. The SFA omits the preoperative orthodontic stage, making it difficult to address these issues.

1) The lack of a relatively stable and reliable reference occlusal position makes it difficult to plan preoperative surgery and accurately predict surgical outcomes. In order to minimise more pronounced post-treatment abnormalities, surgeons and orthodontists need to work more closely together to determine intraoperative jaw position and postoperative occlusal relationships^[13]. During postoperative orthodontics, tooth compensation, arch harmonisation and occlusal relationships are performed simultaneously, which greatly increases the difficulty of postoperative orthodontics^[14].

2) Compensation of the teeth, harmonisation of the dental arches and establishment of the occlusal relationship occur simultaneously during postoperative orthodontics, which greatly increases the difficulty of postoperative orthodontics

3) Patients with significant occlusal deformities often have difficulty in obtaining a coordinated maxillomandibular relationship when preparing the model prior to orthognathic surgery by making a model of the upper and lower jaws in accordance with the ideal tooth positions. In addition, complete correction of the jaw deformity may not be achieved during surgery due to interference with individual tooth positions. Therefore, determining the exact position of bone movement after maxillary and mandibular osteotomy during preoperative design becomes a major challenge in developing the surgical plan and a major test for the operator.

4) After resolving the patient's problem with the main complaint of facial disfigurement through orthognathic surgery, patients are often unable to adhere to postoperative orthodontics until the end of the process. Therefore, explaining the need for postoperative orthodontics clearly to the patient is a very important element in clinical practice. This is because postoperative orthodontics is a key and essential step in restoring good apical interlocking symmetry, arch coordination, and protection of the temporomandibular joint^[15].

5) This is despite the fact that available studies have shown similar efficacy and postoperative stability in the treatment of osseous maxillofacial deformities between the "surgery first" approach and conventional treatments^[16-19]. However, most case reports are retrospective studies, with relatively few prospective studies and animal experiments, and there is also a lack of long-term clinical case-control observational studies with large samples, so the long-term efficacy and stability of the "surgery-first" approach needs to be further investigated.

4. Indications and contraindications for the surgical priority model

4.1 Indications

So far, there are no strict uniform criteria for the selection of SFA cases at home and abroad. The indications for SFA are expanding as research continues, clinicians become more experienced, and science, technology, and materials continue to evolve. Aligned or slightly crowded anterior teeth. 2) Spee curve is flat or slightly curved. 3) Normal or mild forward/backward axial inclination of the anterior teeth (the inclination of the upper and lower incisors can be measured by their axial inclination towards the maxillary or mandibular planes). 4) non-extraction cases, and 5) at least 3 stable occlusal contacts between the upper and lower dentition^{[7][10]. [20]}.

In more complex cases, careful consideration must be given to the complexity of tooth, jaw, and soft tissue coordination during the procedure, preoperative and postoperative orthodontic treatment planning, and the determination of the transitional occlusion.

4.2 Contraindications

SFA is very limiting in terms of patient selection, and in some cases failure to perform preoperative orthodontic debridement may lead to very serious consequences such as failure to correct the midline and open occlusion. Re-orthodontics can become very difficult, increasing the risk of needing a second surgery or even treatment failure. Therefore, the following cases require extreme caution in choosing SFA as a treatment option.

1) Patients with severe crowding, large overdentures, deep Spee curves, severe high angles, and severe incongruence between maxillary and mandibular widths, who undergo surgery without prior de-substitution, may develop severe occlusal interference after surgery, and the postoperative orthodontic levelling of Spee curves will cause mandibular rotation, resulting in unstable surgical results and recurrence. 2) Presence of individual teeth with severe torsion or ectasia. 3) Cases requiring extraction. 4) Patients with severe facial asymmetry or eccentric occlusion. 5) Patients with temporomandibular joint disorders. 6) Patients with active periodontal disease are not suitable for the treatment mode of SFA.

In these patients, the traditional "three-step" surgical treatment plan is still recommended, with at least the anterior region removed as a substitute before orthognathic surgery.

5. Discussion

Surgical priority is an effective way to treat bony Class III malocclusion, but the selection of surgical indications and the timing of surgery have been the focus of controversy. Despite the challenges of the "surgery-first" orthognathic treatment process, this treatment modality has been gradually promoted in clinical work because of its reliable and stable results and some of the advantages that cannot be achieved by traditional methods. For borderline cases, orthodontists should make a detailed treatment plan based on a comprehensive analysis of the patient's age, aetiology, genetics, soft tissue profile, and occlusion, etc. Even though the patient prefers masking treatment over surgical treatment, orthodontists should not intentionally choose masking treatment because the patient wants to reduce the cost and risk of surgery.

Only when clinicians gradually accumulate experience, carefully and rigorously consider all aspects of case selection, strictly grasp the indications, select appropriate cases, carry out reasonable and scientific orthognathic orthodontic treatment design, as well as orthognathic surgeons and orthodontists to fully and closely cooperate with each other, can we expect to obtain satisfactory treatment results^[10].

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