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Surgery-First Approach; from Claims to Evidence: A Comprehensive Review

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A B S T R A C T

The main goals of treatment of dentofacial deformities are to achieve optimal esthetics and ideal functional occlusion. The conventional orthognathic surgical approach includes a long presurgical orthodontic phase, which takes about 18 months. During this phase, the patients' appearance is deteriorated and their motivation to continue treatment significantly decreases. In the surgery first approach (SFA), orthognathic surgery is performed prior to orthodontic treatment, and orthodontic treatment is performed postoperatively to improve dental occlusion and for final settling. The SFA has two main advantages namely shortening of treatment period, and early improvement of the appearance of patient. The SFA has significant advantages especially for class III patients.

This study aimed to review the available articles on this topic published from 2012 to 2019 to achieve a comprehensive understanding of different aspects of the SFA. The databases were searched by two researchers and a total of 11 eligible articles were selected for study inclusion. The results were categorized into two categories of stability of the results of the SFA, and duration of treatment, in comparison with the conventional approach.

Although different aspects of the SFA have been previously evaluated by dental clinicians, a considerable gap of information still exists regarding the details of this approach, which calls for further research in this respect.

Keywords: Surgery First Approach (SFA); Minimal Presurgical Orthodontic Treatment; Surgery First Orthodontic Approach (SFOA)

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INTRODUCTION

Orthognathic surgery is often indicated for patients with an unesthetic facial profile. The conventional orthognathic surgical approach includes three phases of presurgical orthodontic treatment, orthognathic surgery, and postsurgical orthodontic treatment. The presurgical orthodontic treatment phase includes leveling and alignment of the teeth, dental compensation, and coordination of dental arches. Dental compensation helps to determine the actual severity of discrepancy, and decreases the limitations faced by the surgeon in displacement of the maxilla and mandible. Moreover, coordination of dental arches helps in achieving a solid occlusion postoperatively, which may take 12 to 24 months, depending on the severity of malocclusion. The presurgical orthodontic phase is time-consuming and further deteriorates the esthetic appearance of the face, which can negatively affect the psychosocial interactions of patients. It can also decrease the motivation of patients to continue treatment [1-8].

Recently, the surgery first approach (SFA) has gained increasing popularity among orthodontists and oral and maxillofacial surgeons. In the SFA, a presurgical orthodontic phase is not required, and occlusal correction

and finishing are performed after the surgical procedure. This approach shortens the treatment course by 1 to 1.5 years. The SFA has reportedly high success rate particularly in class III patients and those with facial asymmetry, with limited complications. Orthodontic tooth movement occurs at a faster pace after orthognathic surgery due to two main reasons namely coordination of orthodontic tooth movement with the direction of muscle force vectors, and the regional acceleratory phenomenon, which is activated as part of the healing process, and accelerates orthodontic tooth movement. However, the SFA requires high level of clinical expertise and an accurate treatment plan. Also, the method of fabrication of the surgical model is different from that in the conventional approach. The SFA is initiated with presurgical banding and bonding of the entire dental arch without placement of wires [9-15].

The SFA benefits from an osteotomy cut to correct the skeletal and dental problems. Also, a transitional occlusion with appropriate molar relationship is adjusted postoperatively. In this approach, orthodontic treatment is an adjunct to help convert the transitional occlusion to a solid occlusion. The SFA has advantages over the conventional approach, which include (I) resolution of the patient's chief complaint and improvement of facial appearance right after the onset of treatment, (II) the overall duration of treatment decreases by 1 to 1.5 years, depending on the severity of deformity, (III) patient cooperation, self-confidence, overall satisfaction, and quality of life improve. Patient selection is a critical step in the SFA. The SFA is indicated for patients with mild crowding and optimal alignment of the anterior teeth, flat or slight curve of Spee, and normal incisal angles or slight proclination or retroclination.

Similar to all treatment procedures, the SFA has shortcomings and drawbacks as well. Moreover, fabrication and bending of orthodontic wires passively are tiring and time-consuming. On the other hand, occlusion cannot serve as a guide in the surgical procedure in the SFA, and occlusal stability depends on surgical splints. In the SFA, the surgeon should perform the surgical procedure on cases with incomplete alignment of teeth, which further complicates the procedure, necessitating high level of expertise, skills and precision. Moreover, the patients require rigid fixation during the procedure to prevent relapse [16-18].

In general, the following considerations should be taken into account in selection of the SFA:

(I) Precise evaluation for patient selection
(II) Passive bending of wire
(III) Bonding and removal of wire would be difficult postoperatively, and there is a relatively high risk of bonding failure pre- or intraoperatively.
(IV) The extent of jaw movement during the surgical procedure would be greater since surgical correction should be performed while taking into account dental compensation.
(V) Impacted mandibular third molars can further complicate the surgical procedure.
(VI) Postoperative instability during the bone healing phase can cause skeletal instability.
(VII) More orthodontic visits would be required compared with the conventional approach.
(VIII) Close communication between the surgeon and orthodontist would be imperative.

Some clinical and review studies have evaluated the efficacy of the SFA particularly for class III patients [19-21]. This study aimed to review the published literature regarding the SFA to achieve a comprehensive understanding of its different aspects and compare the SFA and the conventional approach regarding the stability and duration of treatment.

Search Strategy

This review study evaluated comparative studies. Two orthodontists electronically searched the Google Scholar, PubMed, and

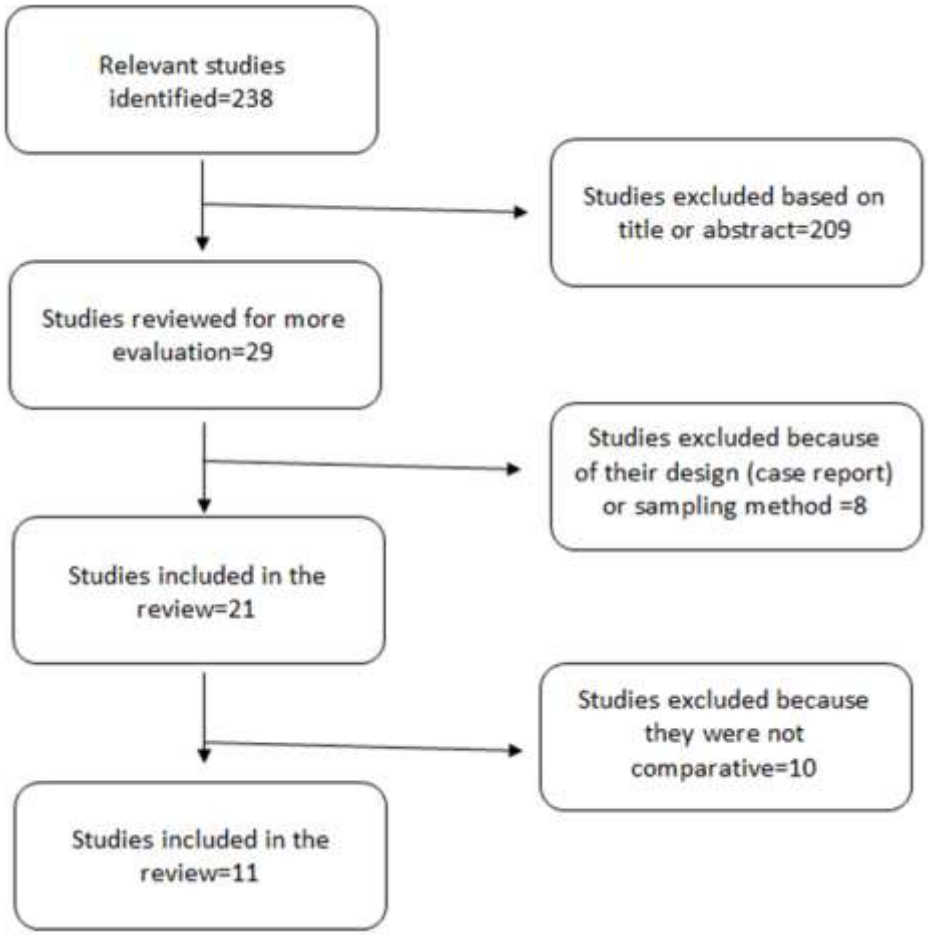

Fig. 1. Flow diagram of the study

Scopus databases using the keywords "SFA", and "minimal presurgical orthodontic" to find relevant articles published from 2012 to 2019 with no restrictions regarding the region, or type of publication. The inclusion criteria were:

(I) English language
(II) Publication date between 2012 and 2019
(III) Human studies on skeletal class III patients
(IV) Patients had to have no history of presurgical orthodontic treatment, or less than 6 months of presurgical orthodontic treatment
(V) Randomized clinical trials and comparative studies comparing the SFA and the conventional approach in all age groups

And the Exclusion criteria were:

(I) Review articles, case reports, and experimental animal studies
(II) Surgical approaches other than the SFA
(III) Positive history of presurgical orthodontic treatment for longer than 6 months.

We extracted data from the selected articles. Type of treatment (the SFA or the conventional approach) was the predictive variable. The amount of relapse in millimeters (mm) and the overall duration of treatment in months were recorded. The included studies had all assessed the stability of treatment.

As shown in Figure 1, of all the retrieved articles, only 11 met the eligibility criteria. The full-text of these articles was retrieved and

reviewed by two orthodontists.

Of 11 studies, 9 were retrospective and 2 were prospective studies. None of the studies was a randomized clinical trial. The extracted information included the study design, sample size, type and class of malocclusion, type of intervention, and the surgical approach (Table 1). A total of 11 articles including 655 patients were finally analyzed; of 655 patients, 338 had been treated by the SFA, and 317 had been treated by the conventional approach. All patients had skeletal class III malocclusion. A total of 655 patients were evaluated in terms of duration and stability of treatment. In terms of type of surgery, 484 patients had undergone bimaxillary surgery and 171 had undergone mandibular surgery alone. Also, 29 patients had undergone bilateral vertical subcondylar osteotomy for mandibular setback and correction of asymmetry [28] Of all patients, 86 had undergone extraction of maxillary premolars [23-25]. The amount of relapse of the maxilla and mandible was calculated by comparing the position of the maxilla and mandible immediately after surgery and at the time of debonding in all studies, except for one study that evaluated relapse during a 20-month period [10].

Treatment time

All studies reported shorter duration of treatment in the SFA compared with the conventional approach. Also, duration of postsurgical orthodontic treatment was longer in the SFA, except for one study that reported no significant difference in this respect between the SFA and the conventional approach [24]. The mean overall duration of treatment with the SFA was 18.39 months in the reviewed studies. This value was 23.34 months for the conventional approach according to comparative studies. Assessments revealed that the SFA is an efficient and effective approach that can shorten the treatment course. Shorter duration of treatment in the SFA is due to three anatomical-physiological factors. The first factor is the coordination of direction of orthodontic tooth movement after surgery with the direction of muscle force vectors, which can enhance the efficacy and power of mastication.

The second factor is faster tooth movement due to decreased involvement of dentition in occlusion. The third factor is faster postoperative tooth movement as the result of the regional acceleratory phenomenon and subsequent increase in the number of osteoblasts and osteoclasts and bone turnover [3]. It has been proposed that patient satisfaction after the SFA highly depends on accelerated tooth movement. Most reviewed studies reported shorter duration of treatment in the SFA.

The overall duration of treatment in the reviewed studies ranged from 14.3 to 20.88 months in the SFA and 22 to 25.31 months in the conventional approach. Only one study reported no significant difference in duration of treatment between the SFA and the conventional approach [23].

The reviewed studies reported that the duration of presurgical orthodontic phase was 1 to 5.53 months in the SFA and 12.9 to 18.1 months in the conventional approach. Two studies by Kim et al, and Park et al. [23-25] reported maxillary premolar extraction in 86 patients; the overall duration of treatment, and the duration of postsurgical orthodontic treatment phase in the abovementioned two studies were longer than the corresponding times in other studies. The overall duration of treatment in patients who underwent tooth extraction and treated by the SFA was averagely 25.114 months while this value was 25.7 months in the conventional approach. However, the mean overall duration of treatment in patients who did not undergo tooth extraction was 15.7 months in the SFA and 22.4 months in the conventional approach. The findings indicated that tooth extraction can prolong the course of treatment. Thus, in order to maximally benefit from the SFA and shorten the course of treatment, the SFA without tooth extraction should be adopted, if possible. Jong et al. assessed the factors related to the duration of treatment course; of which, considering the vertical skeletal pattern, the difference in gonial angle before and immediately after the surgical procedure had a significant correlation with duration of treatment [27].

Table 1. Summary of the reviewed articles

Ref/year	Article type	Sample of volume	Type of Sample	Aim	Intervention	Results
Byungju Joh 2013 (22)	Retrospective study	32 patients (16 presurgical phase was shorter than 6 months)	skeletal and dental Class III malocclusion	Compare changes in the hard and soft tissues and the treatment efficacy of 2-jaw surgery combined with nonextraction treatmen	2-jaw surgery (Le Fort I and bilateral sagittal split ramus osteotomy setback) without extraction	No significant differences between the MPO and CPO groups in the hard and soft tissue cephalometric variables.
Jong-Wan Kim 2013 (23)	Retrospective study	26 patients	Class III malocclusion	compare the patterns of surgical change and postsurgical relapse	mandibular setback surgery with minimal orthodontic preparation and upper premolar extraction	minimal orthodontic preparation group showed a larger amount of surgical setback and greater postsurgical counterclockwise rotation and forward movement of the mandible.
Yang Zhou 2014 (24)	retrospective cohort study	40 patients	skeletal Class III malocclusion	compare the treatment efficacy, and postsurgical dental and skeletal stability between MPO and CPO for patients with skeletal Class III malocclusion who had orthognathic surgery	2-jaw surgery	similar extents and directions of skeletal changes in patients with Class III malocclusion.
Heon-Mook Parka 2014 (25)	Retrospective study	36 patients conventional,24 patients SFA	Class lll malocclusion	To investigate the differences in the amount and pattern of the maxillary incisor inclination change in skeletal Class III patients treated with extraction	bimaxillary surgery and upper premolar extraction	The results of this study might provide basic data for predicting the amount and pattern of maxillary incisor inclination inclination change in SFA for skeletal Class III two-jaw surgery patients.

				of the maxillary first premolars and two-jaw surgery between conventional orthognathic surgery and surgery-first approach		
Jong Woo Choi, 2015 (10)	prospective study	24 standard and 32 surgery-first approaches	Skeletal Class III Dentofacial Deformity	compare the standard and surgery-first approaches as well as test a novel presurgical simulation method for treating class III malocclusion patients with a surgery-first approach	maxillary impaction or advancement and mandibular setback	The surgery-first orthognathic approach without presurgical orthodontic treatment was found to be predictable and applicable to treat class III dentofacial deformities
Tongyue Wang 2016 (26)	retrospective cohort study	55 patients (29 patients were treated by OFA and 26 patients were treated by SFA)	mandibular prognathism	examine the postoperative changes of the condylar position after SFA orthognathic surgery in patients with mandibular prognathism	mandibular setback surgery	Regardless of the timing of the operation (OFA vs. SFA), perioperative and postoperative changes of the condylar position after mandibular setback surgery are equivalent.
W. S. Jeong 2016 (27)	prospective study	45 patients in the surgery-first group and 52 patients in the traditional orthodontics-first group	skeletal class III dentofacial deformities	compare the total treatment time of the surgery first orthognathic approach without pre-surgical orthodontic treatment to that of the traditional orthognathic approach, and to analyze factors that correlate with the total	maxillary impaction or advancement and mandibular setback	The surgery-first orthognathic approach can dramatically reduce the total treatment time, with no major complications.

				treatment duration.		
Han-Sol Song 2017 (28)	retrospective study	29 patients	skeletal Class III malocclusion and facial asymmetry	to use 3D-CT to evaluate transverse skeletal and dental changes, including those in the buccolingual dental axis, between patients with skeletal Class III malocclusion and facial asymmetry who had undergone two-jaw surgery with and without presurgical orthodontics	one-piece Le Fort I osteotomy and mandibular bilateral intraoral vertical ramus osteotomy	Preorthodontic orthognathic surgery may be a clinically acceptable alternative to Conventional orthognathic surgery as a treatment to achieve stable transverse axes of the dentition in both arches in patients with skeletal Class III malocclusion and facial asymmetry
Xiaotong He 2019 (29)	retrospective cohort	24 patients in orthodontic-first approach and 20 patients In surgery-first approach group	skeletal Class III malocclusion	to characterize condylar displacement and surface remodeling after bimaxillary orthognathic surgery in adult patients with skeletal Class III malocclusion treated by surgery-first approach or orthodontic-first approach	Le Fort I osteotomy and BSSRO with or without genioplasty	Similar patterns of 3D condylar displacement and surface remodeling were observed in patients treated with either surgery-first approach or orthodontic-first approach.

MPO: Minimal presurgical orthodontics; CPO: conventional presurgical orthodontics; OFA: orthodontic-first approach; SFA: surgery-first approach; BSSRO: bilateral sagittal split ramus osteotomy.

This finding may be explained by the effect of stronger vertical loads applied, as well as sagittal split ramus osteotomy fixation, which is less stable and requires a longer treatment course. For the horizontal skeletal pattern, the difference in A-MP line before and after the procedure had a significant correlation with the duration of treatment, which can be due to the significant displacement of point A during surgery and subsequent prolongation of treatment course. Of dental factors, the U1/SN (maxillary incisor exposure) and IMPA landmarks showed an inverse correlation with duration of treatment. In terms of soft tissue parameters, the difference in stmi-Me/sm-stms (vertical lip/chin) and interlabial gap immediately after surgery and after debonding had an inverse correlation with duration of treatment.

Duration of treatment is also related to the following parameters:

(I) Host factors such as the magnitude of dental compensation of the skeletal discrepancy (dental crowding and anteroposterior, transverse, and vertical compensations), age and cooperation of patient

(II) Surgical factors (the amount of setback or advancement, fixation method, and muscle adaptation)

Stability of treatment

A total of 10 articles evaluated the treatment stability and the amount of relapse in 558 patients. Jaw stability after the SFA is a common concern for both the patient and dental clinician. Previous studies have reported greater relapse in the SFA compared with the conventional approach [30-31]. However, the available systematic reviews [3] have reported similar rate of relapse for the two approaches. For more accurate assessment of stability, future studies with longer follow-ups after debonding are recommended. Nonetheless, conduction of randomized clinical trials for the comparison of the two approaches is difficult due to the existing ethical concerns. Song et al, and Byugiu et al. reported similar rate of relapse by direct measurement between the two groups [3,24-28]. Xiatong et al. [29] and Wang et al. [26] reported similar rate of relapse between the two groups by measuring the magnitude of condylar displacement and condylar remodeling after surgery, respectively. Also, Jeong et al. [6] reported similar rate of vertical stability between the two groups. Of the reviewed studies, Jong et al. [10] found no significant difference between the two groups regarding LAFHR, AB-Np, SNA and IMPA landmarks for relapse and reported similar results between the two groups in terms of treatment stability. In contrast to the results of the aforementioned studies, some studies have pointed to a difference in the amount of relapse between the two groups. In assessment of the vertical plane, Kim et al, and Zhou et al. [23,24] reported greater counterclockwise rotation of the mandible after surgery in the SFA group. Also, Kim et al. [32] reported greater horizontal relapse in the SFA (2.4 mm versus 1.6 mm), which can be due to the mismatch between the two arches. They reported that the percentage of patients with > 3 mm relapse in the SFA group (39.1%) was twice the rate in the conventional group (15.8%). Nonetheless, the frequency of relapse < 1.5 mm in the conventional approach was higher than that in the SFA. Moreover, they showed maximum relapse in the first 6 months, postoperatively. Zhou et al. [24] reported maximum horizontal relapse in the first 6 months, postoperatively, which can be due to progressive regeneration of muscles and clockwise rotation of the adjacent segments intraoperatively. Also, maximum vertical relapse occurred in the first 3 months, postoperatively. The magnitude of relapse in the mandible is related to factors such as the amount of setback, condylar position, fixation method, muscle tension, interference of the bony segments, and presurgical orthodontic phase. Another study suggested the magnitude of primary overbite as an indicator for prediction of the magnitude of relapse following mandibular setback, such that each 1 mm excess overbite caused 0.449 mm sagittal relapse of the mandible. They also reported that when the magnitude of mandibular setback is > 15 mm, it negatively affects the horizontal stability of the mandible.

Moreover, Lee et al. [20] reported that the greater the increase in the vertical occlusal dimension after surgery, the less predictable the position of point B would be after treatment. Studies have recommended the use of anchor plates to improve postoperative stability in use of class III elastics and prevent forward movement of the jaw.

CONCLUSION

This review study showed that the SFA can shorten the course of treatment given that tooth extraction is not required. The reviewed articles reported longer postsurgical orthodontic phase in the SFA. The results regarding the stability of treatment following the SFA were controversial. It is important that the surgeon and orthodontist take the necessary measures to maximize postsurgical treatment stability in the SFA. The results of this review study should be interpreted with caution since there was no randomized clinical trial in the reviewed articles.

CONFLICT OF INTEREST STATEMENT

None declared.

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