

Surgery First Orthognathic Approach for Skeletal Class III Malocclusion Corrections-a Literature Review

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Management for patients with skeletal Class III malocclusion is orthognathic surgery which involves both orthodontics and surgery. Nowadays, there are two approaches for orthognathic surgery: orthodontics-first and surgery-first approaches. The orthodontics-first approach, or presurgical orthodontics treatment, causes longer treatment time and worsens facial appearance before surgery compared with a surgery-first approach. Conversely, with the surgery-first approach or the surgery-first-orthognathic-approach (SFOA), correction can be resolved more rapidly. SFOA needs high level skill of orthodontist and surgeon and also needs good cooperation between them to accomplish best results. The purpose of this article is to review the concept, indications, contraindications, the stages of treatment and advantages, and disadvantages of SFOA.

Keywords: Surgery first approach, Surgery first orthognathic approach, SFOA, No presurgical orthodontics, Skeletal anchorage system, Regional acceleratory phenomenon, RAP

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Based on case reports and some comparative studies, this literature review aims to elucidate the notion of SFOA treatment with its indications and contraindications, treatment plan considerations, advantages and disadvantages, treatment outcomes, stability and relapse.

There are two broad approaches to correction of jaw malrelationships which, from an historical perspective, first developed with orthodontic preparation followed by orthognathic surgery, and later with the introduction of the so-called surgery-first approach.

Prior to 1960, orthognathic surgeries for correcting mandibular prognathism were performed without preoperative orthodontic treatment. The development of modern orthognathic surgery began in 1954 when Caldwell and Letterman⁽¹⁾ developed a vertical ramus osteotomy technique. The bilateral sagittal split ramus osteotomy (BSSRO) from an

intraoral approach was introduced by Obwegeser in 1957 and, interestingly, vertical osteotomy from an extraoral approach was carried out on other side for the same patient by Trauner⁽²⁾.

Maxillary Le Fort I osteotomy was first reported by Langenbeck in 1859⁽³⁾ for post-traumatic retrognathic maxilla. He developed techniques for immobilizing the maxilla using a bone graft between the pterygoid plate and maxillary tuberosity. Subsequently, several surgeons followed and developed and modified his surgical techniques that oral and maxillofacial surgeons of today use.

Combining orthodontics and surgery began after World War II. Development of the lateral cephalometric radiograph showed that orthodontists could provide good occlusion for patients if the anterior teeth were uprighted over basal bone before surgery. In 1969 Converse and Horowitz⁽⁴⁾ stated that preliminary orthodontic treatment provided proper dental alignment and arch coordination before surgery. For treatment planning of facial skeletal anomalies, Obwegeser⁽²⁾ formulated treatment principles applicable to orthodontists and oral surgeons. His Principle No. 11 stated that, "A good occlusion does not automatically make a good profile and vice versa"; his

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Principle No. 21 was that, “Orthodontics can help a lot but it can also make the necessary surgery almost impossible”, emphasizing the need for combining orthodontics and oral maxillofacial surgery. Moreover, he also noted the goal of presurgical orthodontics with good treatment planning was an essential process for correction of facial skeletal anomalies. Presurgical orthodontic treatment became part of the conventional approach for treatment of dentofacial anomalies cases.

The conventional approach for correction of severe dentofacial anomalies consists of presurgical orthodontic treatment, surgical treatment and post-surgical orthodontic finishing. According to this approach, presurgical treatment is a crucial for satisfactory surgical treatment and stable results^(5,6). The objectives of presurgical orthodontic treatment⁽⁷⁾ before orthognathic surgery consist of:

1. Dental decompensation for positioning the teeth over their basal bones without considerations for the bite relationship to the opposite arch;
2. Leveling and aligning the teeth, relieving any crowding;
3. Coordinating upper and lower dental arch forms;
4. Divergence of roots adjacent to surgical sites where interdental osteotomies are planned.

Orthodontic treatment before orthognathic surgery reveals the true skeletal discrepancy preoperatively⁽⁸⁾ and helps to determine the required dental decompensations which would otherwise limit fully correcting the skeletal deformity⁽⁹⁾. Presurgical orthodontic procedures usually produce satisfactory results and are considered routine. However, this process can be time-consuming, taking as long as 24 months⁽¹⁰⁾, depending on the complexity of orthodontic treatment requirements⁽⁹⁾. In addition, there are worsening lip profile, masticatory discomfort during preoperative orthodontic treatment, and psychosocial problems associated with delay in responding to the patient’s usual complaint concerning facial esthetics treatment⁽¹¹⁻¹³⁾.

Because of the long-term orthodontic preparation, there may be complications such as dental caries, gingival recession and root resorption⁽¹⁴⁾. These are claimed disadvantages of the conventional approach that require two phases of orthodontic treatment.

In 1988, Behrman and Behrman⁽¹⁵⁾ introduced the concept of “surgery first and orthodontics second”. They claimed that the normalized surrounding soft tissues (lips, cheeks and tongue) settled teeth into

better positions after surgery, facilitating remaining orthodontic tooth movement and reducing the total orthodontic treatment period. However, so far there is no solid evidence that supports their notion because of few reports of comparative clinical trials. Preliminary data from Chang Gung Memorial Hospital⁽⁶⁾, Taiwan, indicated that preoperative orthodontic treatment could not greatly help in vertical and transverse plane corrections. In a comparison of outcomes of the two approaches, Wang et al⁽¹⁶⁾ showed correction of transverse discrepancy can be achieved by segmental osteotomies without main presurgical orthodontic treatment.

Nowadays the concept of surgery-first followed by orthodontic treatment has been brought back to apply to orthognathic surgery cases in orthodontic centers in Korea, Japan and Taiwan. This concept and technique is called “SFOA” (Surgery-First-Orthognathic-Approach) or “SFA” (Surgery-First approach) which is defined as starting with the surgery with no presurgical orthodontic procedure and the orthodontic treatment is performed postoperatively⁽¹⁷⁻¹⁹⁾. The concept of this technique is for no prior tooth movement or minimal tooth decompensation for one to two months in cases of occlusal interference, to use surgery to rapidly achieve facial esthetic improvement that is usually the patient’s chief complaint at the beginning of the treatment⁽²⁰⁾. Daniel and Huang⁽⁶⁾ reported that SFOA could still have a minimum pre-orthodontic preparation period about two to three weeks for recording data, treatment planning, set-up model surgery, bonding and banding of orthodontic brackets and inserting surgical arch wire and hooks.

Indications and contraindications for Surgery-First Accelerated Orthodontic Surgery

Since each patient has individual conditions involving malocclusion and dentofacial deformity, there are no specific criteria for using SFOA. The likely candidate patients for this technique are patients who do not want delay in achieving an esthetic result or who want to improve both function and esthetic but they cannot afford the cost of extended orthodontic preparation. However, Liou et al⁽²⁰⁾ suggested to restrict this technique to skeletal Class III cases requiring two-jaw surgery, with well-aligned to mildly crowded teeth, mild curve of Spee and mild proclined/retroclined incisors teeth. In skeletal Class III cases without indication for needing extractions, Baek et al⁽¹⁴⁾ required at least three stable occlusal stops with positive overbite of six anterior teeth and existing arch coordination.

Furthermore, the patients should be of appropriate age to proceed with surgery.

Wolford et al⁽²¹⁾ suggested that orthognathic surgery should be delayed at least until growth was virtually complete or, basing timing of surgery on age, about 15 years for females and 17 to 18 years for males. However, they noted that such surgery for both maxilla and mandible could be carried out at an earlier age to attend to a patient's orofacial function and psycho-emotional concerns, with the understanding that, because of continued growth, further surgery may be required. Alexander et al⁽²²⁾ provided support for Wolford et al's clinical findings noting that, in their semi-longitudinal growth study, subjects with untreated skeletal Class III malocclusion continued to have more mandibular growth relative to maxillary growth throughout adolescence. This is evidence for the need to take skeletal age into account when planning correction of skeletal discrepancies, and for warning the parents of adolescent children any perceived benefits of early surgery could be reversed with continuation of discrepant jaw growth.

On the other hand, case reports of surgical orthodontic treatment of young patients with skeletal Class III malocclusions can be found, such as by Villegas et al⁽²³⁾, sometimes with not totally planned outcomes. It is worthwhile reviewing this report of the treatment by these authors of three patients who were all 12 year-old females and who were concerned about facial appearances. The first patient assessed as at mid-stage of adolescent growth had severe skeletal Class III, and was treated with 21 months of presurgical orthodontics, then bimaxillary surgery including bilateral condylectomies, and a further year of post-surgical orthodontics; by then, growth was complete. The second patient, who was assessed as approaching the end of adolescent growth, had three months of pre-surgical orthodontic treatment and was classified as an SFOA case. After surgery, she had 16 months of orthodontic finishing; although there was some continuation of mandibular growth it was not significant enough to upset the orthodontic outcome. The third patient was at mid-adolescence and had a combination of 22 months of pre-surgical orthodontics followed by bimaxillary surgery and another 12 months of orthodontics. In this case, also, there was some residual mandibular growth but the overall result was considered satisfactory. Despite the satisfaction with these three outcomes, they also provide a warning that accelerating correction with an early surgery-first approach, increases the risk that there may be subsequent

mandibular growth leading to an undesirable outcome.

Thus, growth assessments, such as serial cephalometric radiographs, hand and wrist radiograph, and cervical vertebral maturation in the lateral cephalometric radiograph and other developmental signs should be used to determine cessation of bone growth.

The contra-indications for SFOA are severe crowding, arch in-coordination, severe vertical or transverse discrepancy and patients with high expectations of treatment outcomes in terms of dental esthetics and stable occlusions⁽²⁴⁾.

Treatment planning considerations

As with conventional orthognathic surgery, the treatment plan for SFOA must be considered whether the problems may be with the maxilla, mandible, or both jaws. Moreover, the antero-posterior correction can change vertical and transverse jaw relationships. A three-dimensional analysis using a study model set-up can demonstrate and simulate pre- and post-treatment conditions to help surgeon and orthodontist plan proper treatment.

The treatment plan considerations should be to evaluate the upper incisor inclinations in order to determine how much decompensation is desirable and thus, whether or not premolar extractions for decompensation of upper incisors⁽²⁵⁾; and whether or not posterior maxillary impaction while increasing occlusal plane, will improve incisor inclinations⁽²⁶⁾; or whether to use skeletal anchorage after surgery to distalize the posterior segments of maxilla in order to provide space for uprighting the incisors^(18,19,27). Moreover, the degree of transverse discrepancy between the two arches can be corrected by planning segmental osteotomy in severe cases, or resolving by arch coordination and elastics in a post-surgical orthodontic phase⁽²⁸⁾. The vertical problems are usually related with anteroposterior problems and should be corrected with posterior maxilla impaction or postoperative orthodontic treatment⁽¹⁴⁾ depending on whether the problems are associated with dental interferences not corrected before surgery. However, the occlusal interferences derived from non-level occlusal plan, supra-erupted teeth and improper buccopalatal inclination of posterior teeth will not be corrected simply by surgery.

Most clinicians employing SFOA follow the three stages concept of surgery-first orthognathic surgery consisting of pre-operative procedure, surgical procedure and post-operative orthodontic procedure.

1. Pre-operative procedure

Laboratory procedure

“Set-up models” are used to predict and simulate dental positions and arch coordination for decision on surgical jaw movement. Liou et al⁽²⁰⁾ suggested to set-up model surgery in proper molar relationships with a positive overbite that is opposite to the conventional approach which uses decompensated incisors as the guide to predict the final occlusion. Moreover, they suggested how to set up models in various circumstances. For example, a non-extraction case could be set-up with molar Class I relationship; in case of lower first premolar extractions, molars could be set up in Class III relationship; and set up molars Class II in cases of maxillary first premolar extractions.

Baek et al⁽¹⁴⁾ reported a different and precise technique for setting up models in skeletal Class III with two jaws surgery cases. This required use of a semi-adjustable articulator with separation of the dental and base sections of the study models for set-ups to take separate account of required dental alignments and skeletal changes, and preparation of intermediate and final surgical wafers. This enables the surgeon to determine the required skeletal base movements. However, orthodontists must have experience and confidence that they can move teeth after the surgery with the same results as the model set-up.

Pre-surgical clinical procedures

In most cases, the brackets and archwires are placed a few days before surgery⁽²⁵⁾ and passive stainless steel wires are adapted to all teeth for preventing any tooth movement. Some orthodontists use nickel-titanium (NiTi) alloy archwires^(5,18) because they want immediate tooth movement after surgery. This is different from the conventional presurgical orthodontics treatment which, after achieving required teeth alignments, uses large dimension stiff archwires for providing the strength to support intermaxillary fixation (IMF)⁽²⁹⁾. However, Liou et al⁽³⁰⁾ claimed that the rapid tooth movement can occur three to four months after surgery, beginning the use of NiTi wires immediately following SFOA.

Alternatively, Baek et al⁽¹⁴⁾ suggested the archwire can be bonded directly to tooth surfaces to function as an arch bar a few days prior to surgery. Although direct wire bonding is comfortable for the patient, it is difficult to remove the bonded wire and replace with brackets during the healing period. Preoperative orthodontic preparation can also allow

use of active arch wires when there are premature occlusal contacts derived from crowding.

2. Surgical procedure

In 2011, Liou et al⁽²⁰⁾ suggested specific guidelines for using SFOA to treat cases of skeletal Class III and skeletal Class II in three dimensions; vertical, sagittal and transverse, whereas other clinicians^(24-26,31) treated only Class III deformities. There are clinical reports of SFOA being applied for treating bimaxillary protrusion⁽³²⁾ and asymmetry cases⁽¹⁸⁾, but without extended clinical trials.

In vertical discrepancy, deep curve of Spee can cause occlusal interference because there has not been presurgical orthodontic correction. It has been suggested to treat some cases with deep bite with subapical osteotomy, anterior segmental osteotomy⁽³³⁾ or treat with post-surgical orthodontic appliance for correcting dental interferences. However, in applying the SFOA approach, the correction of the vertical discrepancy by anterior or posterior maxillary impaction can create anterior or posterior rotation of the mandible that will improve or worsen the profile of skeletal Class II or skeletal Class III. However, Baek et al⁽¹⁴⁾ suggested posterior maxilla impaction can decrease occlusal interference and increase the amount of mandibular backward rotation.

In most cases requiring correction of transverse discrepancy, the SFOA and conventional orthodontics-before-surgery approaches are the same, both relying on maxillary segmental surgery. Some cases have negative buccal overjet more than a half molar width but coordinated arches are correctable because it is associated with large skeletal Class III discrepancy where combined maxillary advancement and mandibular set-back are required. If the crossbite discrepancy is more than a molar width on each side, they could be coordinated surgically by a three-piece Le Fort I osteotomy. Alternatively, the narrow maxilla could be treated by surgical assisted rapid palatal expansion⁽³⁴⁾.

While bone plates are used for rigid fixation, the length of time that a surgical splint is used following surgery depends on the orthodontist. Some clinicians⁽¹⁸⁾ use the splint only during surgery; other authors suggest to leave the splint postoperative 4 to 6 weeks^(14,28). Nagasaka et al⁽¹⁹⁾ and Sugawara et al⁽³⁵⁾ used removable surgical splints which consist of a lingual bar and ball-end clasps. The splint can be designed for use in upper or lower arch depending on the treatment objectives in the post-operative period. Grinding of the occlusal surface of splint while using

intermaxillary elastics can allow opposing teeth to be extruded and uprighted. Whether the anterior part of splint has acrylic coverage depends on the orthodontist's need to prevent extrusion of incisors or allow anterior teeth eruption. For example, the Gelb-type⁽³⁶⁾ splint is suggested to maintain intrusion of posterior teeth because it has acrylic coverage over occlusal of posterior teeth only. This design will lead to mandibular upward and forward rotation and chin advancement.

3. Post-operative procedure

The objectives of orthodontic treatment after surgery in the SFOA technique are dental alignment, arch coordination, and allow occlusal settling, that together might take another 6-12 months^(6,25). This period can speed up orthodontic tooth movement especially after orthognathic surgery because there is an increased alveolar bone blood flow during the healing process with stimulation of bone turnover called the Regional Acceleratory Phenomenon (RAP)^(28,30). This is found in cases with extractions and after dentoalveolar osteotomy, segmental osteotomy and interdental distraction osteogenesis^(37,38). The postsurgical orthodontic treatment could begin as early as one week to one month postoperatively^(5,18,20,39). Some authors suggested to wait four to six weeks⁽²⁸⁾.

Liou et al⁽³⁰⁾ suggested the archwire should be activated immediately in order to take advantage of RAP, and allow teeth movement without surgical splint and intermaxillary fixation (IMF)⁽²⁵⁾. After surgery, if the teeth need adjustments of their positions, light elastics or active palatal/lingual arches can be used for controlling arch coordination and guiding and stabilizing the jaw positions⁽²⁵⁾.

Recently, temporary anchorage devices, such as miniplates and miniscrews have been suggested for use with SFOA. The Skeletal Anchorage System (SAS)^(19,27,35) consisting of mini-plates and mini-screws which was developed by Dr. Sugawara in 1992⁽⁴⁰⁾ has become popular in orthodontics and used as a temporary anchorage device (TAD) fixed in the jaw. Sugawara⁽⁴¹⁾ suggested for the maxilla, miniplates placed at zygomatic buttresses to assist in intruding and distalizing upper molar teeth while miniplates are placed at the anterior ridge of the pyriform opening in order to intrude or upright upper anterior teeth and protract upper posterior teeth. In the mandible, miniplates can be placed in the ramus and body of mandible for intrusion, protraction and distalization of lower teeth. However, the implantation sites of miniplate depend

on the objectives of postsurgical orthodontic treatment, the thickness of cortical bone and designs of the miniplate. SAS may be used for orthopedic effect or orthodontic effect, depending on magnitude and duration of force which the orthodontist chooses to use in each case.

SAS has been utilized to meet the likely greater needs for orthodontic corrections after SFOA. The miniplates are placed at the same time as the surgery for moving the entire dental arch and completing any remaining corrections required following SFOA. SAS should not be used to support tooth movements until after bone healing to avoid disturbing the effect of the osteotomy repositioning of the dento-alveolar segment. Daniel and Huang⁽⁶⁾ suggested that SFOA may be applicable in cleft lip and cleft palate patients even though their dental crowding and malocclusion may be more severe than with non-cleft patients and require longer post-surgical orthodontics.

Advantages of SFOA

Because SFOA improves facial esthetics at the early stage of treatment, it can provide patient satisfaction. It is claimed that this technique provides efficient and shortened treatment time^(6,19,20,25,28) of around one to one and half years or less⁽²⁰⁾. After surgery, orthodontic tooth movement can be easily achieved because the teeth are usually not occluded. The rapid tooth movement can occur also because of the RAP effect^(20,25,30,42) noted previously. However, the treatment time varies depending on the complexity of remaining malocclusion problems and the orthodontist's experience⁽²⁸⁾.

Liao et al⁽²⁵⁾ showed that a SFOA group of patients required less treatment time than a presurgical orthodontic group (342 ± 127 days versus 512 ± 103 days, respectively). Yu et al⁽⁵⁾ showed a treatment course for one patient of only four months. Some authors^(14,19,35) reported total average treatment time approximately 9 to 12 months. Villegas et al⁽¹⁸⁾ found that they could complete correction of significant dentofacial asymmetry in as little as seven months. The different total treatment times for SFOA depend on the severity of individual dento-skeletal problems, techniques of surgery, orthodontic mechanics, cooperation and biological response as well as desired results for each patient.

Disadvantages of SFOA

The prediction of the final occlusion is most challenging and time-consuming⁽²⁸⁾, so the clinician's

experience and skill are very important for achieving predictably satisfactory results^(14,25,28). There are many factors that the orthodontist should consider, such as the skeletal discrepancy, limitations of tooth movement, prospective position of the teeth, treatment time required, complexity of passive surgical wire bending, and risk of bonding failure before and during surgery. Furthermore, after surgery-first correction, patients may not be enthusiastic to move on the second orthodontic phase, leaving an outcome that would not satisfy the important clinical goal of best possible conditions for orthodontic stability.

Also, because timing of surgical treatment relates to jaw growth, patients would have delay of correction until adolescent mandibular growth is considered to be complete, whereas presurgical orthodontics could be carried on during the final period of growth⁽⁴³⁾.

Treatment outcome, skeletal stability and relapse

Wang et al⁽¹⁶⁾ found no significant differences in transverse dental changes, canine and molar inclinations with and without presurgical orthodontics for correcting skeletal Class III. Their study indicated that by first correcting the transverse discrepancy by orthodontic tooth movement, it was not necessary to coordinate arch widths after surgery. If any transverse discrepancy is out of range for orthodontic correction, segmental osteotomy of the maxilla will be needed. Moreover, they disagree with the belief that locking force from occlusal interference might be one of the factors interfering with presurgical tooth movement.

Ko et al, belonging to the same Taiwanese group as Wang et al⁽¹⁶⁾, in another report⁽⁴⁴⁾, showed no difference in anteroposterior changes in skeletal Class III with or without presurgical orthodontic treatment, including the amount of skeletal Class III correction, postsurgical relapse and treatment duration. The treatment options in presurgical orthodontic period were designed depending on the severity of the skeletal Class III malocclusion. The results showed the skeletal and dental changes after presurgical period were not different between patients groups with and without extraction.

The relapse rate of mandible set-back was not significantly different comparing both groups but Ko et al's surgical-first group had a greater ratio of relapse around 27.8% whereas the orthodontics-first group had 8.6% for relapse larger than 4 mm. They concluded that the greater relapse in the surgical-first group resulted from the orthodontic treatment attempting to correct

open bite after surgery and then inducing chin projection.

Baek et al⁽¹⁴⁾ showed SFOA approach in skeletal Class III patients without extraction, two-jaw surgery using Le Fort I with maxillary posterior impaction osteotomy and BSSRO technique. Because of posterior impaction of the maxilla, the point A still maintained its approximate antero-posterior position along with improved upper incisor inclination causing immediate improvement of nasolabial angle.

Nagasaka et al⁽¹⁹⁾ showed a case of over corrected skeletal Class III and immediate improvement of soft tissue profile after surgery. They reported use of intermaxillary elastics with SAS for guiding occlusion and decompensating incisors, and claimed that after a total treatment, their patients had good occlusion, balanced profile and still stable results in the following three years.

Conclusion

Even if SFOA for correcting skeletal Class III malocclusions has the advantages of shortened total treatment time and early response to a patient's need, there are limitations particularly relating to later mandibular growth, so that careful case selection, adequate diagnosis, predicting and simulating correction with the model setup is required. Experience of surgeon and orthodontist are important factors in applying the appropriate treatment method taking account of patient needs and goals.

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Potential conflicts of interest

None.

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การรักษาความผิดปกติของกระดูกโครงสร้างขากรรไกรและใบหน้าประเภทที่สามโดยวิธีการผ่าตัดก่อนการจัดฟัน

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การรักษาทางทันตกรรมจัดฟันร่วมกับการผ่าตัดร่วมกับการผ่าตัดกระดูกขากรรไกรเพื่อแก้ไขการสบฟันผิดปกติร่วมกับโครงสร้างกระดูกขากรรไกรประเภทที่สาม ในปัจจุบันการรักษาดังกล่าวสามารถแบ่งได้เป็นสองแบบคือ การรักษาด้วยทันตกรรมจัดฟันก่อนการผ่าตัดและการรักษาด้วยการผ่าตัดก่อนการรักษาทางทันตกรรมจัดฟัน ผลของการจัดฟันก่อนการแก้ไขโครงสร้างใบหน้าด้วยการผ่าตัดนั้นผู้ป่วยมักประสบปัญหาเรื่องความสวยของใบหน้าที่มีลักษณะแย่งลงร่วมกับระยะเวลาการรักษาที่ยาวนานขึ้น ปัญหาดังกล่าวสามารถแก้ไขได้อย่างรวดเร็วโดยการผ่าตัดก่อนการรักษาทางทันตกรรมจัดฟันต้องอาศัยทักษะความชำนาญและการร่วมมือกันเป็นอย่างดีของศัลยแพทย์และทันตแพทย์จัดฟันเพื่อให้เกิดผลการรักษาที่ดี จุดประสงค์ของบทความปริทัศน์นี้หวังผลเพื่อชี้ให้เห็นถึงแนวคิดของการรักษาโดยการผ่าตัดก่อนการจัดฟัน ข้อบ่งชี้ ข้อจำกัด แนวทางการรักษา ข้อดีและข้อเสียของการรักษาด้วยวิธีการผ่าตัดก่อนการรักษาทางทันตกรรมจัดฟัน
