Review article

A Review on Current Treatment Modality of Mandibular Prognathism

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Abstract

Mandibular prognathism has been described as one of the most severe maxillofacial deformities. The etiology involves systemic disease, genetic influence or neuromuscular imbalance. Treatment modalities include growth modification, comprehensive orthodontic treatment and combined orthodontic-orthognathic surgery. The early treatment attempts to restrain the prognathic mandible with external force. Skeletal anchorage is also currently used in conjunction with orthopedic appliance. The camouflage treatment is done in more severe cases using various techniques and other adjunctive procedures such as the use of skeletal anchorage and induction of regional acceleratory phenomenon. Mandibular set back can be done in combination with other surgeries to eliminate prognathic jaw. The surgical first approach and the minimal pre-surgical orthodontics (MPO) technique have been popular lately, but careful case selection is necessary. The stability and several factors that contribute to unfavorable treatment outcome are reported.

Keyword: Prognathic mandible, Class III treatment, Stability

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Introduction

The prevalence of Class III malocclusion has been described between 1 %[1,2] to over 10 %[3] depending on ethnic background, sex, age and diagnostic criteria used.[4] The prevalence increases in Asian ethics ranging from 4 -5 % for Japanese5, 12-14.5 % for Chinese[6,7] and 19 % for Korean population.[8] Among the disporportion of Class III skeletal dysplasia which can be manifested as a mandibular prognathism, maxilliary deficiency or a combination of both, the prognathic mandible has been described as one of the most severe maxillofacial deformities.[9] The etiology of mandibular prognathism varies greatly. It has a possibility to be associated with systemic disease in case of the hyperpituitarism, as growth hormone is over produced resulting in overgrowth

of tissues that are still capable to grow at the time of onset. If the situation emerges during childhood, prominent skeletal growth and large stature occur for the whole body as Gigantism. In contrast, Acromegaly occurs at the adult onset as there is less skeletal growth; the mandible and mandibular condyles appear large together with lips, tongue, nose, paranasal sinuses and sella turcica. In case the mandibular prognathism is associated with excess condylar growth, it can be seen as large mandibular plane angle, flaring of anterior maxillary teeth, anterior open bite and large tongue.[10] Without systemic disease, Class III malocclusions can exist with any variations of the candidate genes that undergo gene-environmental interactions which cause Class III malocclusion comorphologies in the maxillofacial region.[11] Moreover, Class III malocclusion is a polygenic disorder resulting from an interaction of susceptibility genes and environmental factors.[12] There was a research on the family pedigrees that confirmed the monogenic dominant phenotype among members of the families. In addition, the genes that encode specific growth factors or other signaling molecules including Indian hedgehog homolog (IHH), parathyroid-hormone like hormone (PTHLH), insulin-like growth factor-1 (IGF-1), and vascular endothelial growth factor (VEGF) were involved in a mechanical strain in the growth of condyles. Levels of these genes' expression are varied and play an important role in the etiology of Class III malocclusion. Therefore, mandibular prognathism typically relates with familial aggregation.[13] Various genetic models have been described and it is assumed to be a multifactorial and polygenic trait with a threshold for expression. Apart from genetic influence on mandibular prognathism, many evidences show that the environment has an influence on bone remodeling. The alteration of muscle can cause abnormal formation of mandibular shape as it is found that neuromuscular activity is associated with the adaptation of mandibular condyle's structure.[14] There are studies showing that the role of function corresponds with bony structure as the qualitative and quantitative changes in condylar cartilage occur from the decrease in function. This finding was correlated with Moss's functional matrix hypothesis[15] which reported the roles of genetic and epigenetic influence on craniofacial morphology. The complexity of prenatal growth pattern of the mandible may be affected by the morphology of masseter muscle.[16] In addition, mandibular protrusion may be associated with an increase in lower lip closing force.[17] Apart from the role of muscles, prognathic mandible may be the outcome of the lack of interdigitation as there is no physical restraint, which leads to incremental growth of the condyle.[18] Moreover, the mandibular overclosure and anterior displacement probably play a part in Class III discrepancy. It is complicated to make a clear cut decision whether the jaw discrepancy in Class III malocclusion is actually a result of mandibular position, mandibular size or a combination of both.[19]

Treatment modalities

The treatment options for prognathic mandible can be varied depending on age and severity of the problem. At early age, the orthopedic treatment is a treatment of choice to eliminate or to reduce the severity of the problems. The chin cup and/or facemask are used for facial growth modification in Class III treatment. For growing and non-growing patients with mild to moderate Class III problem, the conventional orthodontic treatment is done to compensate abnormal skeletal structure. The range of camouflage treatment is recently widened, but still limited and it must be done with great caution using a variety of techniques. The orthognathic surgery in conjunction with orthodontic treatment can be done in patients with large amount of discrepancy and absence of growth. For patient with mandibular prognathism, sagittal split ramus osteotomy (SSRO) and intraoral vertical ramus osteotomy are common surgical procedures to setback the mandible. The surgery-first approach and the minimal presurgical orthodontics (MPO) technique have been popularized to decrease

the treatment time. In addition, the skeletal anchorage is extensively used to increase the effectiveness of growth modification, camouflage treatment and orthognathic surgery.

Early treatment

Early treatment attempts to restrain mandibular growth by external forces in prognathism patients. It causes downward and backward rotation of the mandible.[20] Chin cup therapy is an example to target on the restraint of the mandibular growth. Even though chin cup produces an upward and backward force, the growth in length cannot be diminished with the appliance, but results in the downward rotation of the mandible instead. Therefore, chin cup therapy is favorable for patient with short face, not for long face. In orthopedic chin cup therapy, prognathic mandible is corrected by backward and downward rotation, whereas change in skeletal dimension is less substantial.[21] The skeletal framework seems to develop before prepubertal period, therefore chin cup appliance can rarely change the inherited prognathic characteristic at the end of the growth.[22] The profile is improved only at the initial stages of chin cup therapy. However, the treatment allows the maxillary growth to catch up with the controls after anterior crossbite correction. The chin cup is also used in conjunction with maxillary protraction appliance. The treatment allows the maxilla to move forward with counterclockwise rotation and the mandible is retarded in growth combined with clockwise rotation.[23]

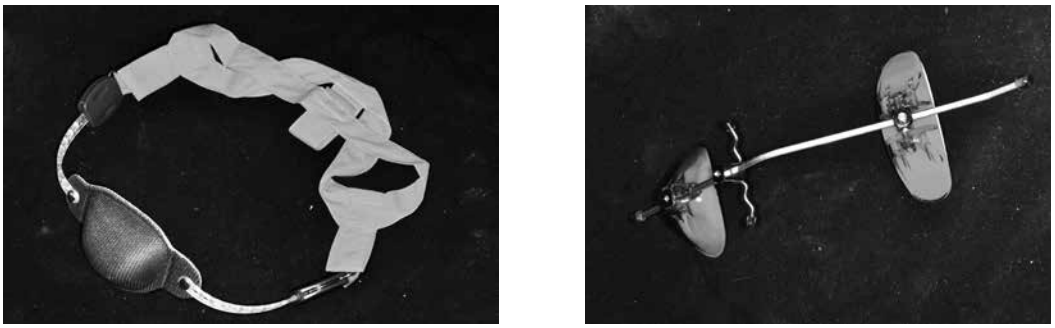

Figure 1 *A. Chin cup. B. Maxillary protraction appliance*

The post treatment observation shows that the maxillary growth modification from the appliance is persisted, but the mandibular growth is still excessive. As the forward growth of the maxilla is maintained, this leads to the conclusion that the combined maxillary protraction and the chin cup appliance is one of the effective therapies. The intermaxillary traction attached directly to skeletal anchorage can also be used during adolescence to move the maxilla forward and simultaneously restrict the forward mandibular growth, therefore preventing the occurance of backward jaw rotation.[20] There are 2 advantages from using skeletal anchorage in Class III orthopedics i.e. 1) minimizing both dentoalveolar changes and downward and backward mandibular rotation and 2) providing greater skeletal changes for the maxilla, mandible, and temporomandibular joint from light continuous force from Class III elastics. The remodeling or relocation of the condylar fossa and distal movement of the condyles are discovered in CBCT superimpositions. They observed that only 20 % of the patients had forward movement of chin. Most longitudinal studies reveal the relapse of prognathic mandible after growth. The characteristics that determine successful chin cup therapy in patients with skeletal Class III malocclusions is the amount of backward rotation from the orthopedic treatment.[24] The greater clockwise rotation of the mandible

during chin cup therapy leads to greater forward rotation and forward mandibular growth as a relapse in later years. The initial cephalometric value that may be used to predict the relapse of mandibular growth is the large gonial angle as it is mostly observed in unsuccessful cases. In addition, the forward position of the mandible that occur after pubertal growth in Class III growing patients is found in patients who have small ramal length, large mandibular length, and obtuse gonial angle.[25] As a consequence, it would be wise to evaluate these parameters in the diagnosis and treatment planning of the growing skeletal Class III malocclusion patients before initiating orthopedic therapy. Skeletal Class III malocclusion should be over-corrected aggressively toward Class II occlusal relationship. The positive overbite and overjet relationships should be achieved in the early treatment to be able to maintain long-term stability of the treatment outcome.[26]

Conventional orthodontic treatment

For patients who are over aged for growth modification, it is always a challenge to make a good choice for the camouflage treatment or the combined orthodontic and orthognathic surgery. The guideline for non-surgical compromised treatment described by Proffit[27] was applicable to only mild skeletal Class III patients who had reasonably good alignment of teeth and good vertical proportion. The acceptable occlusion and reasonable facial esthetics could be achieved by adjustment of incisor position. The reason for not compromising moderate Class III cases is because retraction of the lower incisors often makes the chin more prominent and worsen the facial profile. Vertical problem is also likely to develop by extruding mechanic on posterior teeth and cause long face problem. However, the risk and cost of surgical procedure are higher than conventional orthodontic treatment and patients sometimes refuse to undergo surgery. There are recently wide ranges of techniques which involves camouflage treatment in more severe cases. The treatment can be done with non-extraction or extraction procedure depending on individual plan.

Several studies have shown the successful Class III non-extraction treatment using multibrackets with Class III elastics and multiloop edgewise archwire therapy (MEAW).[28-31] Class III elastics can be used to correct Class III relationship, but it has adverse effects; proclination of the maxillary incisors, extrusion of the maxillary molars and downward and backward rotation of the mandible. These consequences affect the inclination of occlusal plane, the interincisal relationship and the temporomandibular joint, thus it may cause unpleasing facial profile and instability of the result. With caution of those adverse effects, Class III elastics are still the most approved tools in the correction of Class III skeletal discrepancy and the clockwise rotation of the mandible actually benefits prognathic mandible patients with prominent chin. The extrusion of posterior teeth moves the dentition toward Class I occlusion and provides backward mandibular rotation to improve Class III facial profile. In this case, the lower facial height is also increased, so it is contraindicated in patients who have long face. In addition to the conventional archwire, the multiloop edgewise archwire technique is introduced to control individual teeth with the use of Class III elastics, as the tip back activation in posterior segments uprights and distalizes all lower teeth to correct Class III malocclusion. The multiloop edgewise archwire technique can distalize and upright all mandibular teeth without significant clockwise rotation of the mandible which is favorable for patient with openbite tendency.[32] Compliance is still needed for the use of Class III elastics otherwise openbite would be worsened. Instead of attaching Class III elastics directly on the maxillary teeth, microimplant can be placed on the maxilla as point of elastics application to multiloop edgewise archwire in order to decrease upper molar extrusion. As a consequence, the backward mandibular rotation can be prevented.[33] The upper incisors are not proclined, so the positive overjet is mainly obtained from the distal tipping of lower molars

and the retroclination of lower incisors, which improve the patients' profile more than the MEAW itself. When using maxillary skeletal anchorage, the lower dentition is attached to it while the upper dentition is not.

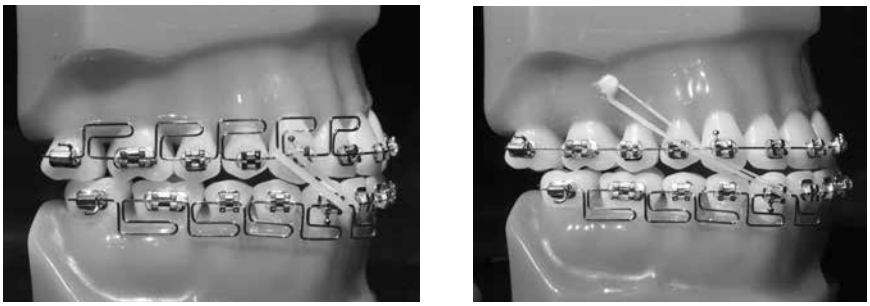

Figure 2 *A. Multiloop edgewise archwire technique with Class III elastics attached to upper dentition.*
B. Multiloop edgewise archwire technique with Class III elastics to maxillary skeletal anchorage.

Nowadays, temporary anchorage devices can be used to correct Class III malocclusion by a variety of mechanics. Microimplant is also feasible to be used with multiloop edgewise archwire to eliminate patient's compliance from wearing Class III elastics. Moreover, they can be placed to correct Class III malocclusion in the upper arch by mesializing total maxillary dentition or in the lower arch by distalizing total mandibular dentition. For mandibular arch, the well-known position for microimplant placement is the retromolar area or the interradicular space between the mandibular first molars and the second premolars, or between the first and second molars. The retraction of mandibular dentition can be done by distalization or uprighting the teeth with elastics or coil springs attached to microimplants. In case the maxillary dentition is to be moved forward, microimplant placement can be done at anterior maxillary arch to protract the maxillary teeth. To avoid arch expansion after outward direction of pull from buccal protraction, palatal implant can be used together with buccal implant to cancel the side effect.[32] The transpalatal arch may be placed to control posterior teeth inclination or the torque compensation in the archwire can be helpful. Even though the microimplants provide much more mechanical advantages than the conventional technique, the biological limitation should be taken into account. Regional acceleratory phenomenon is sometimes introduced combining with microimplant system to reduce the treatment time. Regional acceleratory phenomenon obtains from some types of procedure such as puncturing cortical bone and extracting tooth. There are also other types of procedures that accelerate tooth movement i.e. laser treatment, vibration, and a pharmaceutical approach during retraction of the mandibular dentition and protraction of the maxillary dentition.

Extraction of four premolars, lower premolars, mandibular molars or mandibular incisor can be done to correct Class III problem non-surgically. Lower teeth are removed to provide space for incisor retraction in order to compensate for the prognathic jaw. However, the extraction choices depend on many factors such as tooth-arch discrepancy, cephalometric discrepancy, facial profile, anteroposterior relationships, dental asymmetry, facial pattern and pathologies.[34] Lower premolar extraction is commonly done in Class III camouflage treatment or four premolar extractions can be performed when upper teeth also present with protrusion or significant amount of crowding. Satisfied occlusal relationship and improve facial esthetics can be achieved with the use of Class III elastics for final settling in the borderline surgical-orthodontic patients.[35-36] For patients who have vertical growth pattern, it would be favorable to extract lower molars to close the bite from wedging effect of condyles and to allow counter clockwise rotation of the mandible to

occur. Careful consideration on chin prominence should be made especially in patients who already have an overclosure as it increases with mandibular forward rotation. So molar extraction is more suitable in the prognathic one with vertical growth pattern, but have a chinless appearance. Moreover, the presence of lower third molar is the prerequisite for this type of treatment. The extraction of mandibular molars is also performed when the premolars are missing or the molar itself has unrestorable pathology.[37] Lower second molars can be extracted for dental compensation in moderate Class III cases with vertical growth pattern and normal overjet & overbite can be achieved. The occlusal plane rotates anteriorly and the counter clockwise rotation of the mandible occurs.[38] Jacob *et al.* reported that the potential side effect was the upper second molars elongation. Therefore, opposing teeth should be well controlled especially when extracting the mandibular molars because the treatment time often prolongs during space closing procedure. The extraction of the mandibular incisor is done in some conditions such as mild to moderate Class III malocclusion, mild anterior mandibular tooth size excess, periodontally compromised teeth, ectopic eruption of mandibular incisor and minimal openbite tendencies.[39] Incisor could be extracted when posterior occlusion is acceptable, the crowding of upper and lower incisors is minimal and the overjet should be edge-to-edge relationship or not lesser than negative one millimeter because the extraction space is going to be used for anterior crossbite correction. Even though, successful treatment has been obtained in many studies, the stability needs to be re-evaluated. In summary, the choices of extracting teeth need to be evaluated individually on the case-by-case basis, as there are several factors involved. The examples of extraction option are degree of crowding, shifting of dental midlines, initial and final occlusion, number and size of teeth, quality and quantity of alveolar bone housing, condition of teeth and other environmental factors that affect malocclusion.

Orthodontic treatment combined with orthognathic surgery

The degree of severity, skeletal pattern and age of patient indicate whether Class III treatment can be done with camouflage treatment or orthognathic surgery. According to Baik's study, the camouflage treatment was only recommended for patients who presented with a mild to moderate skeletal Class III discrepancy and a hypodivergent skeletal pattern.[40] Relapse occurred in the long-term after treatment in patients who exhibited late excessive mandibular growth; hence, they were not good candidates for this type of conventional orthodontic treatment. In contrast, a study by Burns *et al.* showed that there were no significant differences in skeletal, dental, and soft-tissue changes between camouflage and surgical groups after the treatment.[41] Therefore, wide range of skeletal dysplasia could undergo conventional orthodontic treatment when tooth movement provided no deleterious effects to the periodontium. However, the optimum treatment plan for skeletal Class III patients should be diagnosed and established properly avoiding unrealistic expectation from clinicians and patients. In general, the orthognathic surgery combined with orthodontic therapy in adult mandibular prognathism is an indication for moderate to severe Class III skeletal discrepancy. The clinical indicator is more clearly explained with the envelopes of discrepancy presented by Proffit and Ackerman in 1985 which showed limitation of orthodontic treatment alone, orthopedic treatment and orthognathic surgical treatment. [2] Moreover, Zeng *et al.* reported of appropriate ANB and L1-MP angle for orthodontic camouflage, as they should be over -3 and more than 82 degrees, respectively.[43] Similarly, Kerr *et al.* showed that the value below -4 and less than 83 degrees were the point at which surgery was almost always carried out.[44] On the other hand, Rabie *et al.* recommended using 12 degree Holdaway angle as a cutoff point in determining the treatment modalities.[45] Stellzig-Eisenhauer, *et al.* also conducted a proper guidline to separate Class III

patients who could be properly treated orthodontically from those who required orthognathic surgery using stepwise discriminant analysis.[46] The study was based on large samples leading to highly significant result for the discriminant function model. The Wits appraisal, length of the anterior cranial base, maxillary/mandibular (M/M) ratio, and lower gonial angle were extracted variables. The resulting equation was Individual score = -1.805 + 0.209Wits + 0.044 SN+ 5.689 M/M ratio - 0.056 Golower. If the individual score was lesser than 0.023, the orthodontic treatment combined with orthognathic surgery was recommended. Nevertheless, limitations of the multivariate model were that the cephalometric analysis and the clinical record used in this study disregarded the transverse components and the facial esthetics. All in all, clinicians' perception and patients' expectation are important in selecting treatment modality as well as other biological and biomechanical limitations.

The surgical correction for mandibular prognathism contains two common methods, which are sagittal split ramus osteotomy (SSRO) and the intraoral vertical ramus osteotomy.[47] Both methods provide desirable occlusion relationship for the patients by setting back the mandible.

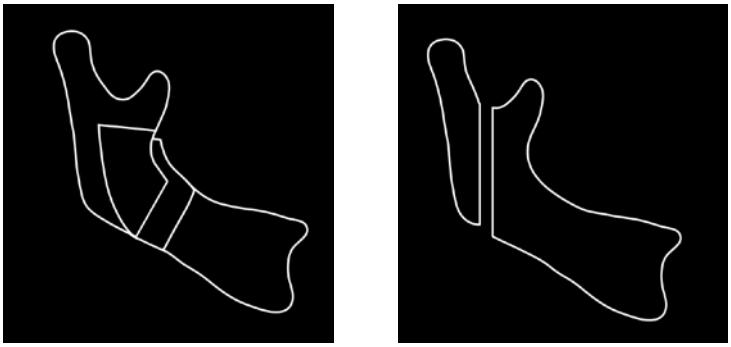

Figure 3 *A. Sagittal split ramus osteotomy. B. Intraoral vertical ramus osteotomy*

In case of mandibular prognathism, dentoalveolar compensation is likely to occur in both maxillary and mandibular arches. The role of orbicularis oris musculature may restrain the lower incisors and alveolar process to retrocline the crown while the roots move forward with the mandible causing lingual tipping of the mandibular incisors along with the alveolar process to compensate for the prognathic mandible. In contrast, upper incisors and upper alveolar process are more proclined as the tongue in prognathic jaw tips them labially. The role of pre-surgical orthodontics is to eliminate dentoalveolar compensation by aligning them in their proper basal bone so that the mandible can be set back more extensively. The better functional and aesthetic results are obtained by proper orthodontic preparation during decompensation procedure. The amount of tooth movement for decompensation may be beyond orthodontic limit. It can be corrected surgically by anterior segmental osteotomy for both upper and lower arches. Apart from setting back the mandible, it is able to move in many directions. For example, moving it backward along the occlusal plane helps decrease in the mandibular plane and anterior facial height. In asymmetrical case, setting back the mandible with different amount can also be done. The transverse dimension can be corrected by either narrowing mid-symphysis or widening with distraction osteogenesis, but the distance should not exceed the amount at which torqueing of the condyles occur.

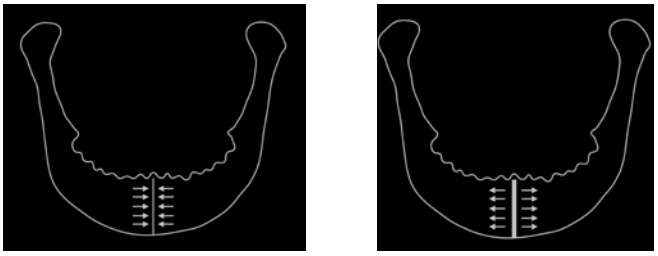

Figure 4 *A. Mandibular narrowing. B. Mandibular widening*

Subapical segmental osteotomy is sometimes used instead of mandibular set back in case of compromised airway or in combination with mandibular set back to increase the amount of mandibular retraction. Class III skeletal discrepancy sometimes occurs with maxillary dysplasia. The surgical correction of maxilla such as maxillary advancement for antero-posterior correction or surgical assisted rapid palatal expansion for transverse correction often needs to increase the stability for maxillary expansion. In more severe cases, distraction osteogenesis is performed to increase bone and soft tissue healing in the osteotomy area, so the jaw can be moved for a greater distance. However, the orthodontic treatment combined with orthognathic surgery is always a multidiscriplinary approach involving decision from surgeon, orthodontist and patient.

The concept of surgery first followed by orthodontic treatment has recently been popularized. This concept and technique are called "surgery - first orthognathic – approach" or "surgery - first approach". The criteria suggested by Sharma *et al.* for this type of treatment were well-aligned to mild crowding, flat to mild curve of Spee, normal to mild proclination/ retroclination of incisors, minimal transverse discrepancy and cases in which minimal decompensation was needed.[48] Liou *et al.* emphasized that the technique treated esthetics first and then occlusion by using osteotomy to solve both skeletal problems and dental compensation.[49] The solid final occlusion was set up with postoperatively adjunctive orthodontic treatment. The benefits of surgery-first approach include improvement of the patient's chief complaint, dental function, and facial esthetics since the start of the treatment and postoperative accelerated orthodontic tooth movement helps decrease difficulty and treatment time in the orthodontic treatment. The regional acceleratory phenomenon occurs after an osteotomy and produces a transient burst of bone remodeling and turnover activities for 3–4 months after the orthognathic surgery.[48]

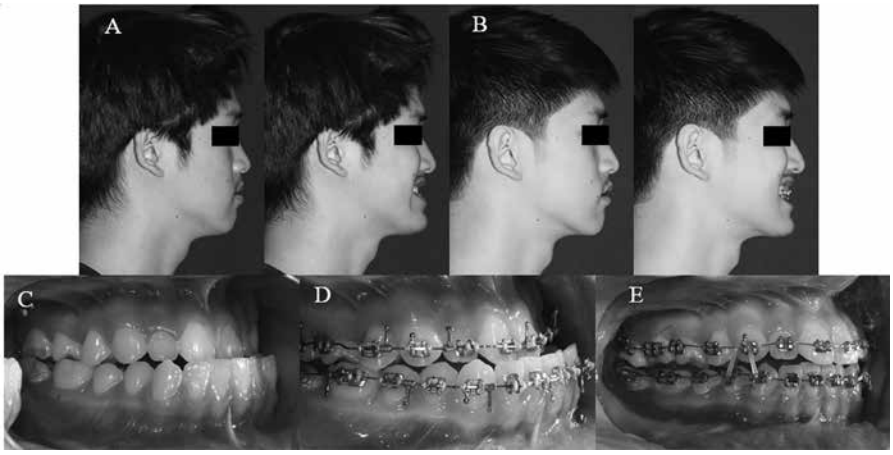

Figure 5 *Example of a surgical-first patient showing immediate profile and occlusal improvement. A. Pre-treatment profile. B. Post-surgical profile. C. Pre-treatment occlusion. D. Surgical archwire passively inserted prior to surgery. E. Post-surgical treatable occlusion*

Even though there is a psychosocial benefit as the patients do not need to suffer from deteriorated facial profile and poor occlusal function during decompensation phase, there is difficultly in matching dentition during surgery because the orthodontic decompensation and arch coordination have not yet been done. Therefore, precise prediction is very important. Some studies reported the instability and unpredictable results from surgical first technique.[50-51] If major orthodontic movement after surgical-first procedure is required, the conventional approach is better selected, otherwise post-surgical orthodontic treatment is prone to be complicated. Recently, the minimal presurgical orthodontics (MPO) technique is introduced to increase the predictable results of surgery.[52-55] The pre-surgical orthodontic treatment is reduced to a maximum of 6 months including maxillary and mandibular arch coordination and eliminating or minimizing occlusal interferences. The advantage of surgical-first procedure is that the patients do not need to experience worsen appearance and occlusion from prolonged pre-surgical phase as much as in the conventional orthognathic surgery. Furthermore, the treatment time is shortened as the post-surgical regional acceleratory phenomenon (RAP) still occurs for post-surgical orthodontic tooth movement.[56-58] In conclusion, the technique selected should be feasible for both orthodontist and surgeon and it will give greatest benefit to the patients in term of function, esthetics and stability. In addition, unrealistic expectation from patients should be initially explained and eliminated.

Stability

The early treatment begins at various ages depending on the types of malocclusion and patient's compliance. There are both stable and acceptable treatment outcomes, and unstable unsatisfactory results in the long term.[21-23,59-61] Types of mandibular rotation & displacement and the degree of forward growth of the mandible are associated with unstable outcomes in patients who undergo early chin cup treatment during mixed dentition.[62] During the early treatment stage, the mandible is rotated downward and backward. The relapse occurs from the growth that causes rotation in an upward-and-forward direction. The forward growth and upward-and-forward rotation occur tremendously after the puberty. The key initial cephalometric features that discriminate stable and unstable groups are the gonial angle, N-A-Pog angle and ramus plane to SN plane angle. The gonial angle is significantly larger at the beginning in the unstable group and increases progressively with the growth. Ferro *et al*. also suggested that the initial low Wits appraisal, increased ramus length, decreased ANB angle, less overbite and high SNB angle were associated with the relapse of the facial growth.[63] Treatment with splints, Class III elastics, and chin cup did not cause backward mandibular rotation; therefore, the forward growth rotation found in follow-up for 9 years could not be considered a relapse from the early treatment. Moreover, it was found that 81.8 percent of the long-term follow-up patients, who underwent combination of RME and chin cup treatment followed by fixed appliances, had stable treament results.[64] The mandibular position shows favorable outcomes meanwhile the RME and protraction from chin cup therapy can be considered an efficient appliance in treating growing girls with mild skeletal Class III malocclusion caused by maxillary retrusion and mandibular protrusion. Most of the early treatment requires second phase of fixed conventional orthodontic treatment using Class III elastics. Treatment in patients with growth potential gives successful results by gradual dentoalveolar remodeling together with proper treatment mechanics and sufficient treatment time.[65] For patients who undergo camouflage treatment which often increases the initial dental compensation without producing noticeable skeletal change. The facial changes are limited, but the satisfactory and stable occlusion on 3-year follow up are obtained with dental and smile esthetic improvement.[66] However, the stability of non-surgical Class III treatment still requires further inverstigation as there are only a small amount of stud-

ies on this type of treatment modality.

The stability of sagittal split ramus osteotomy for mandibular setback surgery with rigid internal fixation was reviewed systematically by Joss and Vassalli. From 14 articles including post-surgical study with time ranging from 6 weeks to 12.7 years, it was found that the horizontal short-term relapse was between 9.9 % and 62.1 % at point B and between 15.7 % and 91.3 % at pogonion.[67] Long-term relapse was between 14.9 % and 28.0 % at point B and between 11.5 % and 25.4 % at pogonion. In the long-term, the amount of relapse did not change significantly from the short-term follow-up. Major relapse usually occurred within 1 year postoperatively.[68] In the long-term, horizontal relapse was 2.3 mm (28.0 %) at B point and 3.0 mm (34.1 %) at pogonion and vertical relapse was 1.6 mm (69.6 %) at B point and 1.7 mm (85.0 %) at pogonion as reported by De Villa *et al.* In contrast, the hard tissue relapse at Pogonion was only 21 % at 1 year after the surgery from Chou *et al.*'s study.[69] The sagittal split ramus osteotomy technique for mandibular setback provides reasonably effective treatment and stable results for both the short and long term follow-ups. Relapse occurs from multifactorial causes such as proper seating of the condyles, the amount of setback, the soft tissue and muscles, remaining growth and remodeling, and gender, whereas the age of patients does not show any correlations.[70] The magnitude of setback is not correlated with the amount of relapse at point B and pogonion, while the amount of vertical relapse at B point and pogonion is significantly correlated with the magnitude of vertical and downward surgical displacement.[68] The post-operative relapse for mandibular setback using sagittal split ramus osteotomy is minimized with intentional ostectomy of the posterior part of the distal segment. Kim *et al.* compared the results between the 2 groups and found that the group with intentional osteotomy had less post-operative relapse at both 6 and 12-month follow-ups.[71] They concluded that this technique might be used to increase long-term stability. The relapse of hard and soft tissue can be different. The stability of soft tissue profile after mandibular setback in SSRO in the long-term showed the relapse at point B and pogonion of 3 % and 13 %, respectively after 12.7-year follow-up. Overall, the surgical technique, the normal process of human aging, the initial growth direction, and remodeling processes affect postoperative long-term stability. Female also exhibits more favorable direction of growth because of further posterior movement of the mandibular soft tissue.[70]

The stability between one and two-jaw surgery are compared in order to evaluate the effectiveness of one-jaw mandibular setback surgery with rigid internal fixation over the two-jaw technique.[72] The main cause of forward movement of the chin is a recovery of ramus inclination in patients undergoing 1-jaw mandibular surgery. The 2-jaw group has rather forward movement of the gonion or upward movement of the maxilla that allows upward-forward rotation of the mandible as a cause of chin position change. It can be concluded that the control of ramus position is better with the 2-jaw surgery. Ngan and Moon described 80 % stability of maxillary position after the surgery. The relapse tendency was less than 4 mm.[32] Therefore, mandibular setback combined with maxillary advancement together with rigid fixation provided acceptably stable results. The unstable result is often found in isolated mandibular setback. The factor that causes relapse of mandibular surgery is condylar sagging because the condyles sag posteriorly when patient is in a supine position during the surgery. The mandible moves anteriorly to its original position resulting in surgical relapse. The 2-jaw surgery is now often performed for Class III correction to increase post-treatment stability. Another factor associates with relapse after mandibular setback is the muscular factor.[47] The reduction of muscular force should be considered because exacerbation of tension in the pterygomasseteric sling or postoperative contracture of the operated soft tissue and muscles lead to unstable results. Moreover, the application of the distal ostectomy technique (intentional ostectomy of the posterior part

of the distal segment) in addition to bilateral SSRO can reduce the relapse significantly as the technique decreases the tension in the pterygomasseteric sling in the posterior mandible.

Conclusion

The selection of treatment plan for mandibular prognathism depends on both biological and mechanical considerations. However, the ideal treatment plan does not always perform; the limitations such as risk and cost must be taken into account. At some points, both clinicians and patients agree to the preferable compromised treatment, hence, precise communication regarding patient's expectation prior to initiation of treatment is essential.

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