Surgical Treatment of a Borderline Skeletal Class III Patient: an Interdisciplinary Approach

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ABSTRACT

Introduction: Class III malocclusion is considered the most challenging discrepancies in orthodontic diagnosis and treatment planning. It is often difficult to classify borderline cases as surgical or non-surgical. The following case report is of a borderline Class III case with several missing maxillary premolars treated via an interdisciplinary approach.

Aim: This clinical case highlights the importance of meticulous diagnosis to obtain optimal results in borderline Class III cases. The significance of an interdisciplinary approach in complex adult orthodontic cases was also discussed. Case Report: Given the complexity of the case, the treatment required a comprehensive interdisciplinary approach with the intervention of multiple specialties including periodontics, prosthodontics, orthodontics, oral surgery and maxillofacial surgery. The presurgical orthodontic stage was achieved in preparation for LeFort I maxillary advancement. Third molars extractions along with implant placement were implemented. Finally, crown placement and connective tissue graft were completed to achieve an optimal result. Total treatment time was 1.7 years (20 months). Patient’s profile and facial appearance were dramatically enhanced, and a stable functional Class II occlusion was attained despite the preexisting skeletal Class III.

Conclusion: Borderline adult Class III cases require a delicate diagnostic approach to be able to distinguish a surgical from a non-surgical approach. Complex adult orthodontic cases require a diplomatic interdisciplinary approach from all required specialties in order to attain the most favorable results.

Keywords: Patient Team Care. Orthognathic surgery. Orthodontics. Malocclusion, Angle Class III. Oral surgery.

1. INTRODUCTION

Class III malocclusions are considered to be one of the most challenging discrepancies in terms of diagnosis and treatment planning. Research has shown that features of a skeletal Class III are not limited to the maxilla and mandible; instead, they are expressed in the entire craniofacial complex (1-5). Class III malocclusion is generally caused by a retrognathic maxilla, prognathic mandible or a combination of both. A fourth possibility may be due to a centric relation-centric occlusion shift leading to the forward positioning of the mandible presenting as pseudo-Class III (6, 7).

Treatment options vary depending on the severity of the malocclusion and age of the patient. They mainly comprise orthopedics using a face mask, orthodontic camouflage and orthognathic surgery. In growing patients, face mask has been the main option for targeting the skeletal Class III. It aims to protract the maxillary complex forward. Nevertheless, side effects are inevitable such as proclination of maxillary incisors and a clockwise rotation of the occlusal plane, ultimately resulting in an increased lower facial height (8, 9). Hugo De Clerk has developed a system for treating mid-face deficiencies in growing patients using titanium miniplates and heavy interarch elastics in both the maxilla and mandible (10). Proper use of temporary anchorage devices (TADs) are being used to camouflage more complicated Class III malocclusions. For example, one method is by placing mandibular screws in order to distalize the entire lower dentition (11-15). However, in severe adult Class III cases, the most appropriate choice would be a combined orthodontic – orthognathic approach (8).

The differentiation between surgical and non-surgical Class III cases is vital; however, it is sometimes difficult in borderline cases. In order to guide the decision-making, several variables have been defined such as the soft
Figure 1. Pretreatment facial and intraoral photographs.

Figure 2. Pretreatment dental casts.
tissue profile, amount of anteroposterior discrepancy (ANB angle), inclination of the lower incisors (IMPA), and other cephalometric variables (1). In addition, an envelope of tooth movement has been defined based on certain physiologic and anatomic limits. If ignored, the results would be detrimental to the teeth and its surrounding structures. Consequently, movements beyond orthodontic limits of the envelope can only be achieved by remodeling facial structures through orthognathic surgery (16,17).

Furthermore, adult orthodontics is increasingly tending towards a more interdisciplinary attitude of treatment. Several reasons may explain this fact, they tend to be out of growth, or their bad oral hygiene may have taken a toll on their dental status. Patients are usually unaware of the complexity of their cases, and hence, the patient’s chief complaint “is often only the tip of the dental iceberg,” according to Melsen (18). Thus, orthodontists have a vital role in meticulously explaining the most ideal treatment plan, which often do not exclusively include an orthodontic approach, to such patients.

This case report presents an interdisciplinary approach to surgically correct a skeletal Class III malocclusion with crossbites and multiple extractions. Treatment results were clinically acceptable, improved facial esthetics and maximum patient satisfaction were achieved.

2. CASE REPORT

Diagnosis and Etiology

A 19-year-old male, B.K., presented to the department of Orthodontics and Dentofacial Orthopedics at the Lebanese University, Hadath. His chief complaint was that he was unpleasant with his appearance and his lower teeth are too far forward. He also stated that he was not comfortable with his occlusion. He did not present any medical problems. He had a dolichocephalic facial pattern with flat cheeks, an adequate extension of the chin, an increased naso-labial angle, and a concave subnasal profile. Upon smiling, he had a moderate lip line, and dental esthetics, and establishing an ideal occlusion.

Intraorally, the maxillary arch had a lytic form with several extracted teeth including both maxillary right premolars and second maxillary left premolar, and a severe arch length discrepancy (ALD) of 23mm. It is apparent that both first maxillary molars were mesio-palatally rotated (Figure 1).

His mandibular arch was intact and presented an anterior crowding of 5mm.

Lateral occlusal assessments showed severe Angle Class III canine relationships on both sides with a negative overjet of 3 mm and an overbite of 2.5 mm. However, the molars had a Class II end-on relation mainly due to the maxillary arch extractions. In addition, a posterior crossbite was found on the right side extending from the canine to the first molar (Figure 2).

In relation with his facial midline, his maxillary dental midline was deviated 3 mm to the right and the mandibular dental midline was deviated 0.5 mm to the right. Although he had anterior and posterior crossbites, a functional shift was not found when his mandible was guided into centric relation. A temporomandibular joint (TMJ) evaluation did not reveal any TMJ symptoms, such as pain, restricted jaw movement, or joint noise.

A panoramic radiograph showed a mesially tipped maxillary right first molar and a slightly distally tipped maxillary right canine. All third molars were present, with normal anatomic structures in addition to absent bone and sinus pathologies (Figures 3 and 4).

The lateral cephalometric analysis (Table 1) demonstrated a skeletal Class III (ANB, -7o; Wits appraisal, -10 mm) due to a severely retrognathic maxilla (SNA, 71o) with a slightly hyperdivergent pattern (MP/SN, 34o). He had well positioned maxillary incisors (I/SN, 103o) and retroclined mandibular incisors (i/MP, 85o). The analysis was done using the Viewbox Cephalometric tracing software (Viewbox Version 4.0.1.7, 2013, dHAL Software, Kifissia, Greece).

The postero-anterior cephalometric radiograph portrayed a narrow maxilla relative to the mandible (Table 2).

Treatment Objectives

The following treatment objectives were established: (1) to correct the concave subnasal profile, (2) to manage the severe maxillary ALD, (3) to level and align mandibular arch and normalize lower incisors inclination, (4) to establish a functional Class II occlusion, (5) to correct the skeletal Class III, (6) to obtain normal overjet and overbite, (7) to enhance the lower facial height, (8) to level the curve of Spee, and (9) to enhance facial and dental esthetics by improving the smile.

Treatment Alternatives

An orthodontic camouflage treatment in this case would have required extracting two mandibular premolars or the use of TADs to distalize the lower dentition. Both methods would have resulted in further retroclination of the mandibular incisors, and hence, worsened the concave subnasal profile. Orthodontics alone could not lead to adequate function and esthetics.

Therefore, orthognathic surgery to advance the maxilla in this case was the only option that targeted the chief complaint of the patient. Mandibular set back was not necessary since the patient has an adequate extension of the chin, and a brachygnathic maxilla was the main cause of the existing skeletal Class III. Skeletal discrepancy correction along with obtaining maximum facial and dental esthetics, and establishing an ideal occlusion would all be possible with this approach.

Because his mandibular incisors were retroclined and a negative overjet was required for surgical preparation, extraction of 2 mandibular first premolars was not chosen to relieve the anterior crowding. Instead, the crowding was targeted by proclination of the lower incisors.

Given the three premolars extracted on maxillary arch and the 3 mm midline deviation to the right, it was decided to open a space for one premolar implant on the right side. The space opening was achieved partly by placing one TAD on the left side to distalize and correct the midline, and an open coil between the right canine and molar to partially distalize the first molar.
Figure 3. Pretreatment radiographs: A, lateral cephalogram; B, frontal cephalogram; C, panoramic radiograph.

Figure 4. Pretreatment peri-apical radiographs.
After discussing the treatment alternatives, the patient accepted the surgical option. This treatment option required the joint efforts of the orthodontist, orthognathic surgeon, oral surgeon, prosthodontist and periodontist.

**Treatment Progress**

The patient was initially referred to the restorative department to treat the dental caries. Meanwhile, the case was discussed with the department of oral surgery regarding the space required for the future implant. Rapid palatal expansion was not performed in this case since the patient is an adult and most of the crossbite was caused by the Class III occlusion that existed i.e. there was no posterior crossbite present once the study models were placed in Class I.

Pre-surgical preparation commenced by bonding both arches with preadjusted appliances using Roth prescription and .022 x .028-in slots (Figure 5). The patient’s arches were leveled and aligned using a series of nickel-titanium (NiTi) wires starting with a .012-in NiTi (total alignment phase was 6 months). Once .017 x .025-in stainless steel wire was reached on the maxilla, the patient was sent to the oral surgery department in order to extract his impacted right maxillary third molar, and an open coil was placed on the right side between the canine and first molar to create a space for the premolar implant. In addition, a TAD was placed on the left side between canine and premolar, and distalization was performed using a NiTi coil spring. Once implant space opening and midlines correction were achieved (total distalization time 6 months), continuous build up of the wires was done until reaching .019x.025-in stainless steel to control torque and slightly expand the maxillary arch for crossbite correction. Pre-surgical models were taken to evaluate the occlusal contacts, and the surgical wires were then placed. The surgical preparation resulted in a negative overjet of 6mm, and the patient was ready for surgery.

Le Fort I was performed in the surgery to advance the maxilla, and mandibular intervention was not necessary in this case. Post-surgery, the patient finished in a functional Class II occlusion (Figures 6 and 7) and he was sent to the oral surgery department to place the implant (total treatment time 20 months). After that, a connective tissue graft was performed for the premolar implant in order to enhance the gingival esthetics of the eventual crown (Figure 8).

**Treatment Results**

Posttreatment records showed that the treatment objectives were fulfilled (Figure 9). The multidisciplinary approach allowed the fulfillment of the patient’s chief complaint and the achievement of optimal results. His profile was significantly improved especially at the level of his lips and cheeks, and his smile esthetics were dramatically enhanced. Dark buccal corridors were greatly reduced. Dental midlines were aligned with the facial midline, and ideal overbite and overjet were achieved. A stable therapeutic Class II was attained with coincident dental midlines as well as an esthetic premolar crown mounted on the implant.

A posttreatment panoramic radiograph (Figure 10) displayed proper root parallelism, and did not reveal any significant sign of root or bone resorption. The implant showed positive signs of good osseointegration.

Lateral cephalometric analysis (Table 1) showed large skeletal changes with a significant improvement of ANB (from -7° to 3°) and Wits appraisal (from -10 mm to -1 mm) owing to the advancement of the maxilla following Le Fort I (SNA: from 71° to 81°). The mandibular angle slightly increased (MP/SN: from 34° to 36°) since the vertical position of the maxilla was not altered by the surgeon. The position of the maxillary incisors was maintained (U1-SN: from 103° to 102°), but his mandibular incisors were slightly proclined owing to the alignment and leveling (IMPA: from 85° to 91°).

Local lateral cephalometric superimpositions (Figure 11) showed a proclination of the mandibular incisors, whereas the maxillary incisors slightly intruded. The maxillary molars moved distally and slightly intruded. As for the general superimpositions (Figure 11), the maxilla significantly moved forward which resulted in the forward movement of the lips and the slight lifting of the nose tip. The mandibular angle did not experience any significant change.

The patient did not report any TMJ discomfort during and after orthodontic treatment, and was ultimately satisfied with his occlusion and facial esthetics.

**3. DISCUSSION**

This case was able to demonstrate the importance of differentiating borderline cases, and the significance of an interdisciplinary approach in complex surgical cases in order to reach optimal results.

To distinguish camouflage from surgical Class III cases, Proffit and Ackermann discussed the three envelopes of tooth movement in orthodontic correction, orthodontic treatment with growth, and orthognathic surgery. They believed that orthodontics alone can protrude the maxillary incisors 2 mm and retrace the mandibular incisors 3 mm (19). However, in this case the negative overjet was greater than 5 mm, not allowing further compensation of the incisors. In addition, the excessive mandibular anterior crowding did not allow retrusion of the incisors without having to extract or distalize using TADs.

According to Kerr et al, the differentiation between surgical and non-surgical patients is done based on three criteria which are the amount of the anteroposterior discrepancy (ANB, -4°), the inclination of the mandibular incisors (IMPA, 83°), and the appearance of the soft tissue profile (Holdaway angle, 3.5°) (20).

This case presented similar critical values in all three aspects; therefore, making the patient a good candidate for a surgical approach.

Martinez et al mentioned that Wits appraisal is a dependable variable in discerning surgical Class III patients. In this case it was initially excessive (Wits = -10 mm) beyond the limits of a typical borderline individual. In his study, he also stressed the importance of proper decomposition in the surgical preparation phase that
**Figure 5.** Progress facial and intraoral photographs (9 months in treatment).

**Figure 6.** Posttreatment facial and intraoral photographs.
Figure 7. Posttreatment dental casts.

Figure 8. 1-year follow-up facial and intraoral photographs.
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Figure 9. Posttreatment radiographs: A, lateral cephalogram; B, periapical radiograph after implant placement; C, panoramic radiograph.

Figure 10. 1-year follow-up radiographs: A, lateral cephalogram; B, frontal cephalogram; C, panoramic radiograph.

Table 1. Lateral Cephalometric measurements.

| Measurements | Norms | Pretreatment | Posttreatment |
|--------------|-------|--------------|---------------|
| LFH/TFH (%)  | 55    | 56.8         | 56.7          |
| SNA (°)      | 82    | 71           | 81            |
| SNB (°)      | 80    | 78           | 78            |
| ANB (°)      | 2     | -7           | 3             |
| SN/H (°)     | 8     | 8            | 8             |
| PP/MP (°)    | 27    | 22           | 23            |
| PP/H (°)     | 0     | 5            | 2             |
| MP/H (°)     | 25    | 26           | 24            |
| MP/SN (°)    | 32    | 34           | 36            |
| I/NA (°)     | 22    | 32           | 20            |
| I-NA (mm)    | 4     | 10           | 3             |
| I/PP (°)     | 110   | 116          | 114           |
| I/SN (°)     | 104   | 103          | 102           |
| I/NB (°)     | 25    | 15           | 25            |
| I-NB (mm)    | 4     | 2            | 4             |
| I-A-Pog (°)  | 22    | 27           | 24            |
| I-A-Pog (mm) | 2     | 6            | 2             |
| l/lMP (°)    | 90    | 85           | 91            |
| ll (°)       | 131   | 138          | 131           |
| AO-BO (mm)   | 0     | -10          | -1            |

Table 2. Pretreatment frontal cephalometric measurements.

| Measurements | Norms | Pretreatment |
|--------------|-------|--------------|
| J-J (mm)     | 65    | 63           |
| AG-AG (mm)   | 86    | 89           |
| AGAG-JJ (mm) | 21    | 26           |
| JJ/AGAG (%)  | 75    | 70.78        |

Figure 11. Cephalometric superimpositions: A, maxillary local; B, mandibular local; C, general.
will lead to a successful surgery. Incomplete decompensation would impede complete surgical correction, and thus, prevent obtaining an ideal ANB angle. In this case, the incisors were completely decompensated to 90°, allowing the surgeon to overcorrect the Class III (ANB post-surgery, 3°) (21).

Several orthodontists consider that a successful orthodontic treatment relies on the combined efforts of different specialties. Proffit believed that the achievement of optimal results is largely associated with a close interdisciplinary cooperation. Melsen is another advocate of interdisciplinary orthodontic approaches, and believes that proper communication between specialties is essential for the formulation of an ideal treatment plan (18, 22). In fact, this can be applied in the abovementioned case where the patient presented to the clinic with a complex malocclusion along with a number of extractions and bad restorations.

The success of the treatment largely depended on the interdisciplinary approach of five different specialties. Prior to the commencement of treatment, an interdisciplinary discussion of the case was done to develop the most appropriate timing for each specialty to intervene. The orthodontist began by aligning the arches, and prior to maxillary molars distalization, the oral surgeon extracted the impacted third molar. Once the case was ready for surgery, the orthognathic surgeon advanced the maxilla via Le Fort I approach. Prior to debonding, the orthodontist verified that the space available for the eventual premolar implant was sufficient. After implant placement, the prosthodontist referred to the periodontal department to perform a connective tissue graft that would eventually maximize the esthetic result of the crown which was visible upon smiling.

The orthodontics department aligned and leveled the arches, and prepared the patient for surgery before sending him to the orthognathic surgeon in order to perform the appropriate surgical procedure. The oral surgery department was responsible for the implant placement and third molar extractions. The prosthodontics along with the periodontics department guaranteed an esthetic result for the crown on implant placement.

4. CONCLUSIONS

Adult Class III cases require a delicate diagnostic assessment to be able to distinguish a surgical from non-surgical approach. The assessment includes, patient’s chief complaint, soft tissue profile, cephalometric variables. The envelope of tooth movement must be taken into account when considering a camouflage treatment, and if required movement is beyond the limits, a surgical approach should be advocated. Complex adult orthodontic cases require a diplomatic interdisciplinary approach from all required specialties in order to attain the most favorable results.

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REFERENCES

1. Stellzig-Eisenhauer A, Lux CJ, Schuster G. Treatment decision in adult patients with Class III malocclusion: orthodontic therapy or orthognathic surgery?. Am J Orthod Dentofacial Orthop. 2002; 122(1): 27-37.
2. Gayer EC, Ellis EE, McNamara JA Jr, Behrents RG. Components of Class III malocclusion in juveniles and adolescents. Angle Orthod. 1986; 56: 7-30.
3. Chang HP, Kinoshita Z, Kawamoto T. Craniofacial pattern of Class III deciduous dentition. Angle Orthod. 1992; 62: 139-144.
4. Mackay F, Jones JA, Thompson R, Simpson W. Craniofacial form in Class III cases. Br J Orthod. 1992; 19: 15-20.
5. Battagel JM. The aetiologic factors in Class III malocclusion. Eur J Orthod. 1993; 15: 347-370.
6. Ngan P, Moon W. Evolution of Class III treatment in orthodontics. Am J Orthod Dentofacial Orthop. 2015; 148: 23-36.
7. Gandhi V, Mehta F, Patel D, Parekh H, Joshi H. Class III Malocclusion Treated by Combined Orthodontic and Orthognathic Approach Along with Growth Prediction: A Case Report. Turk J Orthod. 2020; 33(1): 65.
8. Park JH, Emamy M, Lee SH. Adult skeletal Class III correction with camouflage orthodontic treatment. Am J Orthod Dentofacial Orthop 2019; 156(6): 858-869.
9. Ngan P. Biomechanics of maxillary expansion and protraction in Class III patients. Am J Orthod Dentofacial Orthop. 2002; 121: 582-583.
10. De Clerck HJ, Cornelis MA, Cevidanes LH, Heymann GC, Tulloch CJ. Orthopedic tract of the maxilla with miniplates: a new perspective for treatment of midface deficiency. J Oral Maxil Surg. 2009; 67(10): 2123-3129.
11. Tai K, Park JH, Tatamiya M, Kojima Y. Distal movement of the mandibular dentition with temporary skeletal anchorage devices to correct a Class III malocclusion. Am J Orthod Dentofacial Orthop. 2013; 144: 715-725.
12. Kook YA, Park JH, Bayome M, Kim SK, Han E, Kim CH. Distalization of the mandibular dentition with a ramal plate for skeletal Class III malocclusion correction. Am J Orthod Dentofacial Orthop. 2016; 150: 364-377.
13. Ngan P, Moon W. Evolution of Class III treatment in orthodontics. Am J Orthod Dentofacial Orthop. 2015; 148: 22-36.
14. Park JH, Yu J, Bullen R. Camouflage treatment of skeletal Class III malocclusion with conventional orthodontic therapy. Am J Orthod Dentofacial Orthop. 2017; 151: 804-811.
15. Daher W, Caron J, Wechsler MH. Nonsurgical treatment of an adult with a Class III malocclusion. Am J Orthod Dentofacial Orthop. 2007; 132: 243-251.
16. Antoun JS, Mei I, Gibbs K, Farella M. Effect of orthodontic treatment on the periodontal tissues. Periodontol. 2017; 74(1): 140-157.
17. Profit WR, Ackermann JL. A systematic approach to orthodontic diagnosis and treatment planning. In: Graber TM, Swain BF, editors. Current orthodontic concepts and techniques. 3rd ed. Saint Louis: C. V. Mosby; 1985.
18. Kalia S, Melsen B. Interdisciplinary approaches to adult orthodontic care. J Orthod. 2001; 28(3): 191-196.
19. Profit WR, Fields HW, Sarver DM. Contemporary Orthodontics. 5th ed., St. Louis, MO: Elsevier; 2013.
20. Kerr WJS, Müller S, Dowber JE. Class III malocclusion: surgery or orthodontics? Br J Orthod. 1992; 19: 21-24.
21. Martinez P, Bellot-Arcis C, Llamas JM, Cibrian R, Gandia JL, Paredes-Gallardo V. Orthodontic camouflage versus orthognathic surgery for Class III deformity: comparative cephalometric analysis. Int J Oral Maxillofac Surg. 2017; 46(4): 490-495.
22. Mcneill RW, Profit WR, White RP. Cephalometric prediction for orthodontic surgery. Angle orthod. 1972; 42(2): 154-164.