Treatment of Angle Class I Malocclusion with Severe Bimaxillary Protrusion using Miniscrew Implants and Periodontal Ligament Distraction

KC Prabhat, ND Gupta, Sandhya Maheshwari, Sanjeev K Verma, Lata Goyal, Raj Kumar Singh

ABSTRACT

Bimaxillary dentoalveolar protrusion is common in Asian population. In this patient with procumbent upper and lower lips, excessive lip strain, proclined and protruded maxillary and mandibular incisors with vertical growth pattern, an acceptable treatment result, was achieved with 4-first-premolar extractions. This case report is presented with the aim, to describe the treatment approach for bimaxillary dentoalveolar protrusion using miniscrew implants for anchorage in upper arch and periodontal ligament distraction for canine retraction in lower arch and then retraction of incisors into the newly formed bone distal to lateral incisor. Treatment was completed in 18 months. The patient profile was improved, with reduction in lip procumbency, decrease in lip eversion and protrusion, and decrease mentalis strain. Dentally, the interincisal angulation improved significantly because both the maxillary and mandibular incisors were uprighted after space closer.

Keywords: Bimaxillary dentoalveolar protrusion, Miniscrew implants, Periodontal ligament distraction.

INTRODUCTION

Bimaxillary dentoalveolar protrusion is common in many ethnic groups around the world including Asian population. Common treatment approach for patients with severe bimaxillary dentoalveolar protrusion, facial convexity, lip incompetence, and crowding is to extract 4-first-premolars and then retract the anterior teeth. However, the treatment plan becomes more complex when the patient has hyperdivergent growth pattern, crowding, and deep curve of spee. As these cases demands maximum anchorage or no mesial movement of the posterior teeth, therefore headgear used to be unavoidable fate in these patients. But lack of patient cooperation can result in anchorage loss and unsatisfactory treatment results. This led to the usage of other alternative procedures like skeletal anchorage and periodontal ligament distraction procedure, and so on to save the anchorage. Nowadays, along with the development of implant anchorage and periodontal ligament distraction procedure to retract the canines, more and more patients have benefited without using headgear, or other extraoral appliances. In this case report, the treatment approach for bimaxillary dentoalveolar protrusion using miniscrew implants for anchorage in upper arch and periodontal ligament distraction for canine retraction in lower arch and then retraction of incisors into newly formed bone distal to the lateral incisors was described.

CASE REPORT

A 16-year-old female patient reported to our university orthodontic center with the chief complaint of protruding upper front teeth and lip protrusion. There was no remarkable dental history and her medical history showed no contraindication to orthodontic treatment. Her parents reported thumb sucking habit between the ages 2 and 8 years.

Extraorally: The patient had a normal facial form with no asymmetries but exhibited a severe convex profile and
excessive vermilion show of the upper and lower lips. She had procumbent and everted upper and lower lips, a deep mentolabial sulcus, and excessive lip strain on closure (Fig. 1).

**Intraorally:** She presented with angle class I malocclusion with severe dentoalveolar protrusion (Fig. 2). She showed mild mandibular crowding, 4 mm of overjet, 3 mm of overbite, and coincident midlines. Oral hygiene was poor in this patient. Soft tissue analysis indicated that she had protrusive lips (Table 1).

The panoramic radiograph (Fig. 3) showed no evidence of bony pathology. All 32 teeth were present. After obtaining orthodontic records, all 4-third-molars were advised for extraction, as recommended by her oral surgeon but she was not willing for extraction after mandibular third molar extraction.

The lateral cephalometric radiograph (see Fig. 3) and analysis (see Table 1) showed a skeletal class I malocclusion (ANB = 3°) with severe bimaxillary dentoalveolar protrusion (M × 1 − NA = 12 mm, M × 1 − SN = 36°, Md1 − NB = 14 mm, Md1 − APg = 43°, interincisal angle = 95°). As evidenced by the SN-mandibular plane angle of 42°, the skeletal pattern was hyperdivergent. Study model analysis showed 13 mm space requirement in maxillary arch and 13 mm space requirement in mandibular arch.

She had flaccid and soft facial musculature. The local imbalance in the functional soft tissue surrounding the dentition such as weakness in the facial muscles and thumb sucking habit is a contributing factor for the development of bimaxillary protrusion in this patient. Her family history revealed that her mother and elder sister also have bimaxillary dentoalveolar protrusion. Etiology of bimaxillary dentoalveolar protrusion in this patient seems to be complex, involving both hereditary and environmental factors including soft tissue function and habit.
Table 1: Pre- and post-treatment cephalometric analysis data

<table>
<thead>
<tr>
<th>Area of study</th>
<th>Parameters</th>
<th>Pre-treatment</th>
<th>Post-treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Skeletal</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maxilla to cranial base</td>
<td>SNA</td>
<td>80°</td>
<td>81°</td>
</tr>
<tr>
<td>Mandible to cranial base</td>
<td>SNB</td>
<td>77°</td>
<td>78°</td>
</tr>
<tr>
<td>Basal arch relationship</td>
<td>ANB</td>
<td>3°</td>
<td>3°</td>
</tr>
<tr>
<td>Midfacial length (Co-A)</td>
<td>89 mm</td>
<td>90 mm</td>
<td></td>
</tr>
<tr>
<td>Mandibular length (Co-Go)</td>
<td>109 mm</td>
<td>110 mm</td>
<td></td>
</tr>
<tr>
<td>Differences</td>
<td>20 mm</td>
<td>20 mm</td>
<td></td>
</tr>
<tr>
<td><strong>Skeletal divergency</strong></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Sn-Go Gn (Steiner)</td>
<td>42°</td>
<td>41°</td>
<td></td>
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<tr>
<td>FMA</td>
<td>32°</td>
<td>32°</td>
<td></td>
</tr>
<tr>
<td>“J” Ratio</td>
<td>57 (%)</td>
<td>57 (%)</td>
<td></td>
</tr>
<tr>
<td>Bjork Sum</td>
<td>403°</td>
<td>404°</td>
<td></td>
</tr>
<tr>
<td>Gonial Angle (Ar-Go-Me)</td>
<td>128°</td>
<td>127°</td>
<td></td>
</tr>
<tr>
<td><strong>Dental</strong></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Maxillary incisor angulation</td>
<td>M1-NA</td>
<td>12 mm</td>
<td>4 mm</td>
</tr>
<tr>
<td>M1-SN</td>
<td>36°</td>
<td>21°</td>
<td></td>
</tr>
<tr>
<td>Mandibular incisor angulation</td>
<td>Md1-NB</td>
<td>14 mm</td>
<td>7 mm</td>
</tr>
<tr>
<td>Md1-APg</td>
<td>43°</td>
<td>29°</td>
<td></td>
</tr>
<tr>
<td>IMPA</td>
<td>112°</td>
<td>99°</td>
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<tr>
<td>Interincisal angle</td>
<td>I/I</td>
<td>95°</td>
<td>126°</td>
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<td><strong>Soft tissue</strong></td>
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<tr>
<td>Upper lip to Rickett’s E line</td>
<td>2.5 mm</td>
<td>0 mm</td>
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<tr>
<td>Lower lip to Rickett’s E line</td>
<td>7 mm</td>
<td>2 mm</td>
<td></td>
</tr>
<tr>
<td>Upper lip to Stiener’s S line</td>
<td>5 mm</td>
<td>2 mm</td>
<td></td>
</tr>
<tr>
<td>Lower lip to Stiener’s S line</td>
<td>8 mm</td>
<td>3 mm</td>
<td></td>
</tr>
</tbody>
</table>

A: A point; B: B point; IMPA: Incisor-mandibular plane angle; M1: Maxillary central incisor; Md1: Mandibular central incisor; MP: Mandibular plane; N: Nasion; Pg: pogonion; S: Sella

**Treatment Objectives and Treatment Plan**

In this case, primary treatment objective was to improve the patient’s facial appearance and lip competence by reducing the severe dentoalveolar protrusion and achieve a normal axial inclination of the incisors. Because of excessive proclination of the maxillary incisors and the patient exhibited lip strain on closure, more anchorage was needed to retract the incisors without mesial movement of the maxillary molars. To enhance anchorage, miniscrew implants were used to provide indirect anchorage in maxillary arch between the second premolar and first molar.

Treatment objectives in the mandibular arch included resolving the mild mandibular crowding, uprighting the
incisors, and reducing the dentoalveolar protrusion. To minimize the anchorage need, canine retraction in mandibular arch was done using periodontal ligament distraction procedure and then retraction of mandibular incisors was done into newly formed bone distal to lateral incisors without taxing on anchorage.

The primary skeletal objective was to maintain or to reduce the skeletal divergency. Extrusion of the patient’s maxillary molars would rotate her mandible down and back, increasing her divergency and worsening her profile. Soft tissue objective was to reduce the upper and lower lip procumbency and decrease the lip strain. Treatment objectives for the occlusion were to maintain the molar neuetroclusion, decrease the overjet, maintain the overbite, and to achieve good functional occlusion preferably canine guided.

In summary, based on clinical examination, Cephalometric findings and study model analysis treatment plan was to extract the 4-first-premolars and maximum retraction of anterior teeth with maximum anchorage control to decrease the dentoalveolar protrusion and improve the soft tissue balance.

Treatment Alternatives
The main issue in determining the appropriate treatment plan was the severity of the dentoalveolar protrusion. It was recommended that the 4-first-premolars be extracted to reduce the patient’s lip procumbency. A complete orthodontic fixed appliance and good cooperation with elastic wear or extraoral appliance such as headgear would be needed to maintain the molar and canine relationships and reduce the dentoalveolar protrusion, but anchorage loss often create problem in these approach. To enhance the anchorage, skeletal anchorage was used in maxillary arch and periodontal ligament distraction procedure was used in mandibular arch.

Treatment Progress
A 0.022 inch Roth edgewise appliance (Leone, E Coronado St Ste D Anaheim, CA, USA) was used. Initially, the maxillary and the mandibular arches were banded and bonded. A 0.016 inch NiTi archwires were ligated in the maxillary and the mandibular arches for initial alignment. Mandibular canine retraction was accomplished by periodontal ligament distraction procedure, 1 month after the initial alignment archwire using individual canine distractor. The individual canine distractor was a custom-made tooth-borne, semirigid device. After the bands were fabricated for the canine and first molar, an impression was obtained, the bands were transferred into the impression, and the study cast was made. The device consisted of an anterior section, a posterior section, a screw, and a hex wrench to advance the screw (Figs 4A to C). A 360° activation of the screw produced 0.5 mm of distal movement in the canine tooth.

After the mandibular first premolars extraction, vertical osteotomies were carried out at the buccal and lingual sites of the interseptal bone adjacent to the canine tooth. The vertical osteotomies were connected with an oblique osteotomy extending toward the base of the interseptal bone to weaken the resistance (Figs 4D to F). The distractor was cemented in place after the surgery. The distraction was initiated just after the surgery. An advancement of 0.5 mm was performed per day until each canine tooth was distracted into the desired position. During the retraction of mandibular canine bite raisers were used on mandibular posterior teeth to provide proper disclosure of mandibular canines. The patients were closely monitored during the distraction period and a class I canine relationship was attained after 2 weeks. Intraoral photographs of a patient before and after rapid canine distalization are shown on right side (Figs 4G and H) and on left side (Figs 5A to F) in mandibular arch. After the retraction of the canine in mandibular arch, it was retained for 1 month. The retraction of the four mandibular anterior teeth was done using 0.017 × 0.025 inch SS archwire with closed loop.

Initially, the retraction of all maxillary and mandibular canines via periodontal ligament distraction procedure was planned, but our canine distractor was bulky as custom made distractors were used. So, decision was made to retract the maxillary canine with miniscrew implants. Under infiltration local anesthesia, a titanium alloy miniscrew (1.5 mm diameter, 8 mm in length for upper arch, SK surgicals, Nagpur, India) was inserted into buccal alveolar bone between the maxillary second premolar and the first molar (Fig. 6). The miniscrew implant was tied with ligature wire with second premolar and first molar as a unit to provide indirect anchorage. Retraction of six anterior teeth was started through, K-SIR wire using 0.019 × 0.025 inch TMA wire. This mechanics lasted for 7 months then the miniscrew implants were removed simply by unscrewing them. As the space closure was done bite was deepen. Bite opening was done using 0.017 × 0.025 inch TMA intrusion archwire. Finally, the case was finished using 0.021 × 0.025 inch TMA ideal archwire. At debonding visit (Figs 7 and 8), the patient was given a maxillary removable circumferential retainer and a mandibular lingual-bonded retainer from second premolar to second premolar and she is still in retention phase. The patient was instructed to wear the retainers full time for 6 months, half time for 12 months, then once per week at night indefinitely.
Figs 4A to H: Periodontal ligament distraction procedure to retract the canine. (A to C) Distraction device and lab procedure; (D) Vertical and oblique osteotomies (dotted line) for undermining bone distal to canine; (E and F) Clinical intraoral photograph of extracted tooth and surgical technique; (G) Intraoral photograph of patient before distraction on right side in mandibular arch; (H) Intraoral photograph of patient at end of distraction on right side in mandibular arch

Figs 5A to F: Complete canine distraction procedure with retention device on left side in mandibular arch
**Treatment Result**

After 18 months of treatment, the change in the patient’s facial esthetics was the most dramatic part of her treatment. With extraction of the first premolars and application of periodontal ligament distraction to retract the mandibular canine and then mandibular incisors retraction into newly formed bone distal to the lateral incisor and miniscrew implants as an absolute anchorage for maxillary anteriors *en masse* retraction, significant retraction of her upper and lower lips was achieved. Her lip eversion and dentoalveolar protrusion were improved. In addition, as the upper and lower lips were retracted, mentalis strain was reduced, which improved her chin projection (Fig. 7). Posttreatment intraoral photographs, study models, and lateral cephalogram
and analysis (Figs 8 to 10A to C and Table 1) showed that the maxillary and mandibular incisors were inclined appropriately, and their position significantly improved when compared with the start of treatment. Cephalometric analysis showed maintenance of skeletal divergency (see Table 1). The panoramic radiograph (see Fig. 9) showed adequate root parallelism in the maxillary and mandibular arch, except for the distal root angulation of tooth 41.

DISCUSSION

Treatment objective should be directed toward an ideal occlusion. However, facial forms and incisor prominence differ among various ethnic groups and races. Although there have been published attempts\textsuperscript{13,14} to define a beautiful face, the definition changes as society, and its esthetic values change.\textsuperscript{15} Orthodontists must consider the patient’s opinion because society is becoming more esthetically sensitive. The orthodontist must not simply aim for normal values, without considering each race separately and without considering the patient’s opinion. A patient’s expectation of treatment must be considered first and foremost, because ideals of esthetic profiles vary.\textsuperscript{16}

Bimaxillary dentoalveolar protrusion is quite commonly seen in Asian population.\textsuperscript{4} Kocadereli\textsuperscript{17} found that, when a decrease of lip procumbency is desirable, extracting premolars and retracting incisors is a viable option to achieve these objectives. On the basis of the patient’s chief complaint and the diagnosis of the malocclusion, extracting the maxillary and mandibular first premolars was indicated. When extracting premolars is desired to correct the malocclusion, the treatment plan must address space closure of the extraction sites.

It is well-known that closure of the extraction sites can occur by retraction of the anterior segments, protraction of the posterior segments or a combination of the two, and when it is indicated to prevent mesial movement of the posterior segments in the anteroposterior dimension, this is termed maximum anchorage.\textsuperscript{18} Growth pattern of this patient was hyperdivergent. Anchorage control in hyperdivergent growth pattern patient is critical due to weaker musculature,\textsuperscript{19} narrow buccal and lingual cortical plate,\textsuperscript{20} and very weak occlusal forces.\textsuperscript{21} Headgear has historically been the standard for maximum anchorage;\textsuperscript{7} however, it is always complained even rejected by adult patients because of social and esthetic concerns that certainly will bring anchorage loss and unsatisfactory treatment results.

To augment anchorage, adjunctive appliances, such as a transpalatal bar, a Nance holding arch, palatal implants, or extraoral traction, are usually necessary. Intraoral sources of anchorage include alveolar bone, teeth, dental arches, palatal and mandibular basal bone, differential moment mechanics, and lip musculature.\textsuperscript{18} Renfroe\textsuperscript{22} stated that, to be stable, the anchorage unit must be overwhelmingly more resistant than the teeth being moved. In this case, anchorage in the maxilla was achieved with a miniscrew implant between first molar and second premolar. So far, clinical efficacy and stability of implant anchorage, miniscrews,\textsuperscript{8} and microscrews\textsuperscript{9,10} have turned out to be efficient skeletal anchorage devices, which can provide absolute anchorage for tooth movement that cannot be achieved by conventional methods. Miniscrew or microscrew implants especially have many benefits such as ease of placement and removal and inexpensiveness.

Mandibular anchorage was achieved by retracting canine using periodontal ligament distraction and after that
en masse retraction of four mandibular incisors. Reducing the orthodontic treatment time and controlling the anchorage loss are common aims of research in modern orthodontic practice. Rapid canine distalization is a cornerstone for these goals and was first introduced by Liou and Huang

11 in 1998. After the initial tooth movement by a light or heavy orthodontic force, a lag period of minimal tooth movement persists for approximately 2 to 3 weeks before tooth movement again proceeds. In this case, the canine distraction was completed, while the first molar was still in its lag period or just initiating its mesial movement. The major advantages of rapid distalization were shortening the treatment time, eliminating the need for additional anchorage, and rapid retraction of incisors using the new bone tissue distal to the lateral incisors.

Various investigators have reported a range of mesial molar movement of 0 to 2.4 mm when canine retraction is combined with the use of adjunctive appliances to control anchorage.

15,22,23 When adjunctive appliances are not used while retracting canines with traditional mechanics, 1.6 to 4 mm of mesial molar movement has been reported. In our patient, maxillary incisors were retracted 6 mm and the maxillary molars moved mesially 1 mm on cephalometric superimposition (see Figs 10A to C). Her mandibular incisors were also retracted approximately 6 mm, and the mandibular molars were moved mesially 1 mm.

CONCLUSION

In this patient with procumbent upper and lower lips, excessive lip strain, and proclined and protruded maxillary and mandibular incisors, and vertical growth pattern an acceptable treatment result was obtained with 4-first-premolars extraction plan. Treatment was completed in 18 months and anchorage control was done using periodontal ligament distraction procedure in mandibular arch and miniscrew implant in maxillary arch. The patient’s profile was improved, with reduction in lip procumbency, decrease in lip eversion and protrusion, and decreased mentalis strain. Dentally, the interincisal angulation improved significantly because both the maxillary and the mandibular incisors were uprighted after space closure.

REFERENCES