ABSTRACT

Purpose: Due to the expanding demand for adult orthodontics, the number of cases which require comprehensive dental management is increasing. Adult orthodontic patients can exhibit multiple missing and/or heavily restored teeth, which could lead to an unusual extraction pattern for treatment. However, there is little existing evidence about adult orthodontic treatment of patients who present with irregular extraction. In the present report, we introduce a case with successful treatment outcome for complex problems, including anteroposterior skeletal discrepancy with multiple missing and heavily restored permanent teeth. Material and methods: The patient was a 23-year-old woman case with skeletal discrepancy which required orthognathic surgery for correction. For her comprehensive dental condition, we decided to orthodontically close the spaces of her missing upper left first molar and her extracted lower left first molar. The upper space closure required sinus lift and bone graft to supply sufficient alveolar bone for tooth movement. The lower space was closed by sectional osteotomy at the time two jaw orthognathic surgeries were performed to correct her skeletal discrepancy. Results and conclusion: At the end of the surgical and orthodontic treatments, functional occlusion and an improved facial profile were achieved. This case report provides new evidence and treatment procedures for patients who require a complex extraction pattern

with orthognathic surgery.

Introduction

Orthodontic treatment in adult patients frequently requires interdisciplinary treatment planning [1]. Premature loss of a permanent first molar is one of the most challenging situations for comprehensive treatment [2]. A lack of proper management of early loss of a permanent first molar can lead to malocclusion of adjacent teeth. Long duration of tooth loss can also be associated with alveolar bone loss, which limits the movement of neighbouring dentition [3]. As the number of adult orthodontics patients increases, the frequency of cases associated with permanent tooth loss Is expected to also increase [4-7]. However, there is not enough reported evidence to guide the decision of how adult cases with missing first molar should be treated.

Adult cases sometimes also have associated multiple prosthodontic restorations of which the structures are compromised due to skeletal discrepancies. For these cases, the final design of restoration after correcting the skeletal and occlusal relationship should be taken into consideration. In the present case, the patient exhibited severe skeletal discrepancy associated with restored upper incisors. Additionally, the upper left first molar was missing and the lower left first molar was heavily restored. For these reasons,

the treatment plan included space closure of the upper and lower first molar, together with two Jaw orthognathic surgeries. Here we report an orthognathic case treated with a highly multidisciplinary approach including space closure of both the upper and lower first molar followed by upper incisor prosthodontics.

History

A 23-year-old woman first came to the Department of Orthodontics at Osaka University Dental Hospital in Suita City with complaints of the appearance of prognathism and occlusal disturbance. She had no major medical history. However, her upper right and lower left canines had previously been extracted to improve her severe crowding. Additionally, her upper left first molar had been extracted because of poor prognosis with deep tooth decay. Furthermore, her maxillary incisors had been prosthodontically restored to improve her negative overJet.

The initial facial photographs showed a concave type profile with midfacial deficiency (Figure 1). Gummy smile and long lower facial height with chin deviated to the left could be observed. The initial intraoral photograph showed orthodontically treated maxillary central and lateral incisors which resulted in an edge-to-edge incisor relationship. The maxillary left second molar was mesially tipped and the second

premolar was distally tipped because of the missing maxillary left first molar. Neither of the dental midlines coincided with the facial midline because of asymmetrical extraction, with the maxillary dental midline deviated to the right, and the mandibular dental midline deviated to the left. The mandibular right second molar was half impacted, with mesial tipping.

Figure 1 shows the initial lateral cephalometric and panoramic radiographs. The panoramic radiographs showed that the dentition was moderately restored, including crown restoration and root canal treatments of all upper incisors and the first premolars (Figure 1). The mandibular left first molar showed poor prognosis because of severe alveolar bone loss around the root apex. The floor of the maxillary sinus on the left side extended into the roots of the posterior teeth. The lateral cephalometric analysis (Table 1) showed a tendency of skeletal Class III and excessive anterior facial height in comparison with the normative Japanese mean [8]. In the mandible, the ramus height and body length were significantly long. The maxillary incisors showed slight proclination because of the prosthodontic restoration.

Treatment plan and progress

The treatment objectives for this patient were to correct (1) the skeletal Class III and

concave type facial profile (2) excessive anterior facial height with gummy smile and long face, (3) the left deviation of mandibular dental and skeletal midline, (4) the right deviation of maxillary dental midline, yawing and asymmetrical maxillary dental arch (5) the remaining space on the left side of the maxilla (6) close the space of extracted lower left first molar.

The movement of each bone segment for osteotomy was planned as follows. In order to improve the mid-facial deficiency, deviation and asymmetrical dental arch of maxilla, we planned three-piece LeFort I osteotomy with the extraction of maxillary left first premolar. With three-piece LeFort I osteotomy, it was planned to move the maxilla forward and upward. It was planned to move the midline of the maxillary incisor to the left.

Intraoral vertical ramus osteotomy (IVRO) was also planned to improve the prognathism and deviation of the mandible by moving the mandible backward and upward. It was also planned to move the midline of the mandible to the right. Because of the poor prognosis of the mandibular left first molar, we decided to extract the tooth and close the space by using alveolar osteotomy of the mandible. Moreover, maxillary sinus lift and bone graft on the left side were planned in order to facilitate the space closure and root movement of adjacent teeth. Preoperative orthodontic treatment of the

maxillary dentition aimed to retract the upper incisors and close the space of the upper left first molar. The treatment aimed to turn the mandibular half-impacted right second molar upright. Space remained at the site of the lower left first molar extraction for sectional osteotomy.

After three months of the maxillary sinus lift and bone graft from the chin, fixed 0.021 x 0.025-in preadjusted appliances were bonded on the maxillary left second premolar and the first molar for levelling and alignment. After levelling and alignment, the remaining space was closed by loop mechanics using 0.019 X 0.025-in beta titanium archwire.

A lower lingual arch was placed to turn the man dibular right second molar upright. The crown prostheses of the maxillary central and lateral incisors were redone to match the direction of the incisor axis. After uprighting of the mandibular right second molar with a lingual arch, fixed 0.021 x 0.025-in preadjusted appliances were bonded on the mandibular teeth.

After the pre-operative orthodontic treatment, 6 mm of space remained between the lower left premolar and second molar, which enabled sectional alveolar osteotomy. The wisdom tooth on the same side was moved and aligned in the dental arch in order to substitute for the extracted first molar (Figure 2). After making a treatment plan using a threedimensional (3D) simulation (Figure 3), three-piece LeFort I osteotomy with the

extraction of the maxillary left first premolar, alveolar osteotomy of the mandible and IVRO were performed. The anterior segment of the maxilla was set forward 3 mm and upward 4 mm, and horizontally rotated for dental midline correction with three-piece LeFort I osteotomy. The posterior right segment of the maxilla was moved forward by 3 mm, and the posterior left segment of the maxilla was moved forward by 10 mm. The mandible was set back 5 mm and horizontally rotated for skeletal midline correction with IVRO, and the mandibular left extraction space was closed with alveolar osteotomy of themandible.

After the postoperative orthodontic treatment, all appliances were removed. The active treatment period was 2 years and 8 months. Begg type retainers were placed on both arches for retention, and post-active treatment records were taken after debonding of all appliances (Figure 4). To further improve the lateral soft tissue profile, genioplasty was performed by moving the chin forward 4.0 mm at the same time asremoving the fixation plates.

The post-active treatment panoramic radiograph showed a periapical lesion with maxillary lateral incisors (Figure 4). There was also an uneven appearance of the upper incisor margin, which led to aesthetic problems. Therefore, upper incisor ceramic crowns were renewed after root canal treatment of the lateral Incisors and gingivoplasty

of the upper incisors (Figure 5). The retention period was 2 years and 2 months.

Results

The post-active treatment records showed that most treatment objectives were achieved with good aesthetic and occlusal results (Figure 4). Mandibular protrusion and maxillary deficiency were improved. The long face was corrected. Both maxillary and mandibular midline coincided with the facial midline. As a result, facial profile was improved, and a harmonious facial balance was achieved. Mandibular kinesiograph and electromyogram did not show noticeable functional problems throughout the treatment (Figure 6). Normal overbite and overjet were achieved. The extraction spaces of the maxillary and mandibular left first molars were closed, and multiple tipping teeth were up-righted. The super impositions of lateral cephalograms showed the skeletal and dental changes (Figure 7). In the cephalometric analysis, improvements of the anterior facial height (N-Me, N/PP, Me/PP), mandibular length (Ar-Me, Ar-Go, GO'Me) and inter-incisal angle (HA) were observed (Table 1). The superimpositions of posteroanterior cephalograms showed that the midline of the upper dentition and lower dentition moved 1.5 mm to the left and 2.0 mm to the right, respectively (Figure 8). The midline of the lower dentition did not match the midline of the face due to missing of

the mandibular left canine. The space between the missing upper left first molar was successfully closed with sufficient alveolar bone (Figure 9). CT images during retention showed normal healing of the segmented osteotomy areas (Figure 10), and acceptable occlusion remained even after 2 years of retention phase (Figure 5). After removing the orthodontic appliances, excessive exposure of the upper incisors remained to the level that the patient required improvement. Therefore, gingival resection for the upper incisor was performed followed by aesthetic prosthodontic treatment. Narrowing of the upper dental arch by relapse and mesial inclination of the lower left second molar during retention resulted in an undesirable cross-bite and open bite of the left molar segment. Overcorrect maxillary expansion and fixed retainer could have been considered to avoid this occlusion.

Discussion

With the increase in the number of adult orthodontic patients in recent years, there are an increasing number of cases that require an interdisciplinary approach. As in this case, the orthodontic treatment of adult patients occasionally exhibits difficulties related to multiple missing teeth, such as the first molar [4567]. A missing first molar can result in an inclination of adjacent teeth, maxillary sinus pneumatization, and distortion of dental

arch form [4,9,10]. In addition to these problems in dentition caused by missing teeth, it becomes even more difficult if there is a skeletal discrepancy.

Space management with a missing permanent first molar often has the option of closing the space by tooth movement or prosthetic treatment. When the space is required to improve crowding or labially inclined anterior teeth, orthodontic space closure can become the first choice [11]. Even then, it is still challenging to close the space by orthodontic tooth movement because of its wide gap of extraction. In order to facilitate the root movement of upper left dentitions to close the space, we performed sinus lift and bone graft at the site of the missing first molar. It has also been documented that space closure on the mandible for a missing permanent first molar tends to be more challenging [2]. For this reason, we utilized mandibular sectional osteotomy to close the space rather than performing orthodontic tooth movement.

Recently, three-dimensional (3D) treatment planning has been shown to be effeaive in treating a complex occlusal condition [121314]. Traditional techniques for orthodontic treatment planning that use twodimensional (2D) cephalometric prediction tracings have some limitations. Therefore, magnification, distortion, and/or projection error occur in 2D simulation [15]. These problems may lead to misdiagnosis and compromising the surgical result [15]. 3D treatment planning has been developed to reduce the errors and

improve the limitations of 2D treatment planning. Xia et al. have reported the 3D cephalometric techniques to be an accurate and effective way of predicting treatment [161718]. In the present case, for comprehensive treatment planning, 3D treatment simulation played a significant role in an accurate diagnosis.

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Figure legends

Figure 1. Pre-treatment records (age, 23 years and 6 months), (a) Facial photographs, (b) Intraoral photographs, (c) Panoramic radiographs, (d) Lateral cephalograms.

Figure 2. Pre-operative treatment records before two-jaw surgery {age, 25 years and 8 months), {a) Facial photographs, (b) Intraoral photographs, (c) Panoramic radiographs, (d) Lateral cephalograms.

Figure 3. The three-dimensional orthognathic surgery simulation with three-piece LeFort I osteotomy, intraoral vertical ramus osteotomy, and alveolar osteotomy of mandible on the left side, (a) Pre two-jaw surgery, (b) Post two-jaw surgery.

Figure 4. Post-active treatment records (age, 26 years and 8 months), (a) Facial photographs, (b) Intraoral photographs, (c) Panoramic radiographs, (d) Lateral cephalograms.

Figure 5. Post- retention records (age, 28 years and 10 months), (a) Facial photographs, (b) Intraoral photographs, (c) Panoramic radiographs, (d) Lateral cephalograms.

Figure 6. Mandibular kinesiograph (MKG) and electromyogram (EMG) records

during opening and closing movements of the mandible, (a), MKG of pretreatment, (b), EMG of pretreatment, (c), MKG of post-active treatment, (d), EMG of post-active treatment.

Figure 7. Superimposed lateral cephalometric tracings on the SN plane at S. In the molars, the right first molar and the left second molar were traced, and the left second molar was filled, (a) pre-treatment (black line) and post-active treatment (red line); (b) post active treatment (black line) and post-retention (red line).

Figure 8. Superimposed posteroanterior cephalometric tracings on the latero-orbital plane, (a) pre-treatment {black line) and post-active treatment (red line); (b) post-active treatment (black line) and post-retention (red line).

Figure 9. Periapical radiographs: (a) pre-treatment; (b) during active treatment after sinus lift and bone graft; (c) post-active treatment. CT images with red line of sinus floor: (d) pre-treatment; (e) post-active treatment.

Figure 10. CT images of segmented osteotomy areas after post-active treatment: (a) maxillary right area after segmented LeFort 1 osteotomy; (b) maxillary left area after segmented LeFort I osteotomy and mandibular left area after alveolar osteotomy; (c) mandibular left area after alveolar osteotomy.

Table 1. Lateral cephalometric measurements.