Team approach for orthognathic surgery

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To ensure that orthognathic surgery is successful, functional aspects such as mastication, pronunciation, swallowing and aesthetic factors must be considered. For successful orthognathic surgery, the orthodontist and the surgeon must constantly study and discuss accurate facial analysis, presurgical orthodontics, choice of appropriate surgical methods, and postsurgical orthodontics.

In this article, we will discuss the team approach for successful orthodontic treatment and orthognathic surgery, establishing close cooperation between the orthodontist and surgeon. (Semin Orthod 2019; 25:264–274) ***© 2019 Elsevier Inc. All rights reserved.***

Introduction

Skeletal anchorage devices such as bone plates and miniscrews have expanded orthodontic treatment options compared with those in the past,[1] but orthognathic surgery is still required for adult patients with severe skeletal deformities.

In recent years, orthognathic surgery has improved the effectiveness and stability of treatment. Thanks to improved anesthesia, orthodontic treatment, and surgical methods, there has been an increased demand for active treatment by patients, and more attention is being paid to orthognathic surgery than ever before.[2]

Historically, orthognathic surgery was performed without any presurgical orthodontic treatment and orthodontic treatment was relegated to just postsurgery, if necessary. However, since the 1990s, compensated dentition has been decompensated by orthodontic treatment before surgery after the maxilla and mandibular arches have been coordinated through adjustment.[3,4] In this way, occlusion can be achieved at the time of the orthognathic surgery, providing improved results and less chance of recurrence.

Recently, the development and advances in cone-beam computed tomography (CBCT), 3D cameras, laser scanning and various computer-aided surgical simulations (CASS) have made the creation of diagnostic and treatment plans for orthognathic surgery much easier and more accurate than in the past (Fig. 1).[5,6] Furthermore, the development of orthodontic materials has enabled more efficient orthodontic treatment which is of benefit to patients and surgeons alike. In addition, advances in instruments, fixation methods, equipment, and surgical methods for orthognathic surgery have shortened the overall treatment time and improved the postoperative stability.

Now, model surgeries and splint manufacturing have been streamlined by the use of virtual systems (Fig. 2).[7] At the same time, a growing number of patients are electing the "surgery-first" approach to prevent their facial profile from worsening during the presurgical orthodontic phase. While this approach improves their facial profile early in the process, it requires an accurate, well-established prediction of the outcome to minimize any postoperative problems.[8,9]

For orthognathic surgery to be successful, close coordination between the orthodontist and surgeon is essential and should be based on the initial diagnosis. It may also be necessary to collaborate with prosthodontists, periodontists, plastic surgeons, and other dental specialists, if necessary. This article describes a series of

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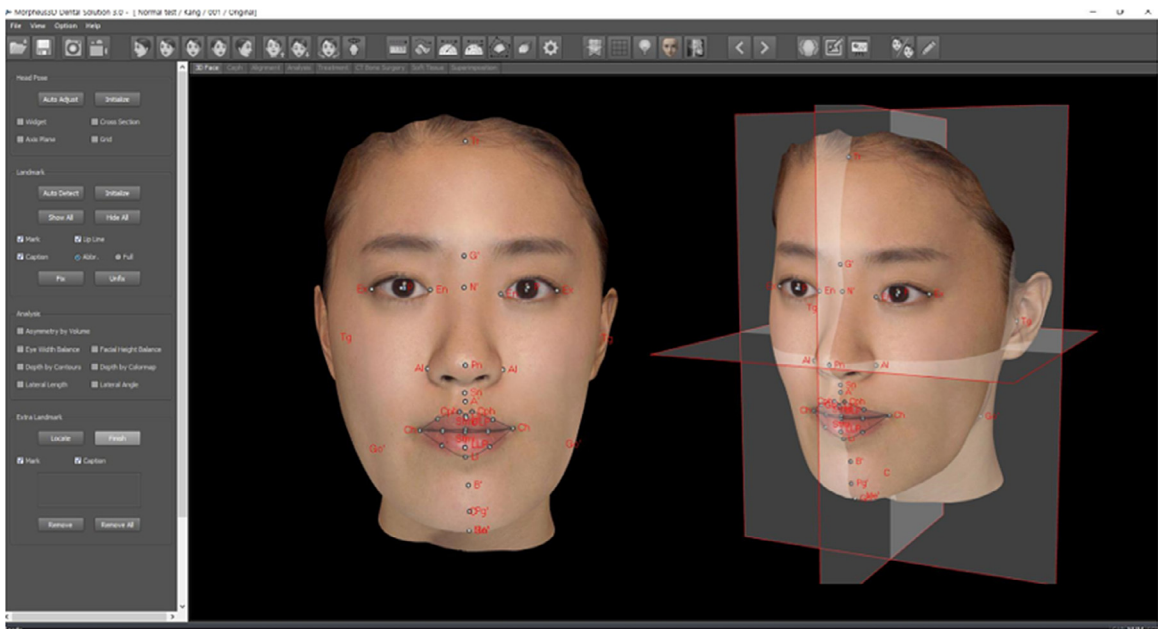

Figure 1. 3D landmark autodetection using Morpheus3D Scanner and CT software (Morpheus, Seoul, Korea).

procedures from diagnosis to finishing of orthognathic surgery and examines the collaboration process between orthodontists and surgeons.

Initial evaluation

Patient consultation

Patients who need treatment for malocclusion tend to visit an orthodontist first and want to finish with orthodontic treatment rather than surgery. However, if the patient just wants to improve their appearance, they tend to visit a plastic surgeon or oral and maxillofacial surgeon first. Acknowledging the patient's specific expectations is important for future treatment planning. The treatment plan will depend on the purpose of the surgery such as to improve a malocclusion, enhance appearance, or both.

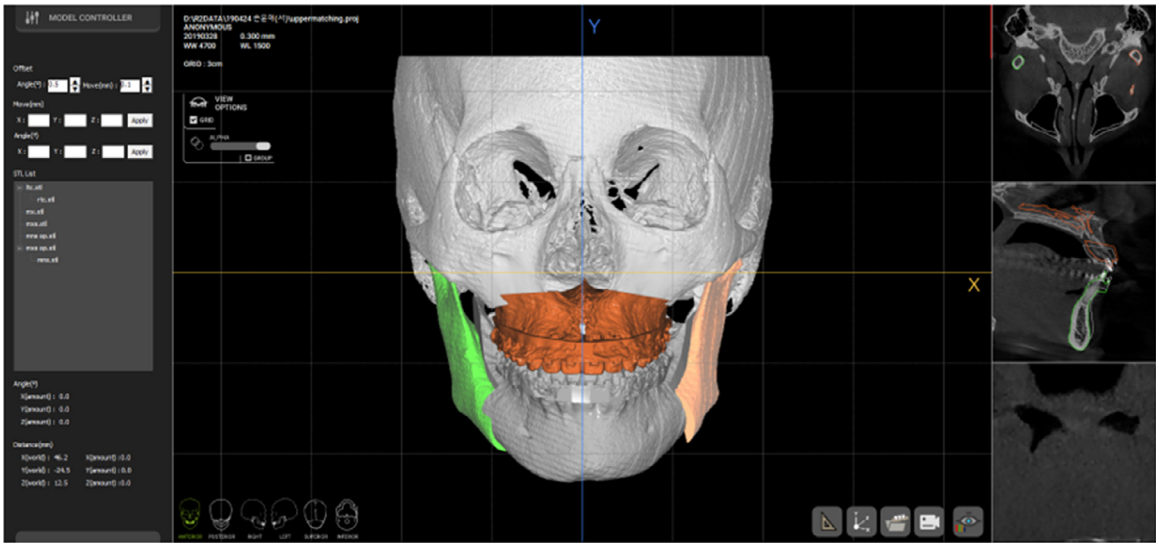

Figure 2. 3D virtual surgery using FACEGIDE software (MegaGen, Seoul, Korea).

Figure 3. (A and B) Stabilization splint was used prior to presurgical orthodontics for temporomandibular joint disorders. (C) A bone scan for temporomandibular joint can also be taken, if needed.

Diagnosis

Surgeons set basic aesthetic treatment goals based on patient complaints and on an aesthetic facial examination conducted with the patient's head in a natural position. Cephalometric measurements and an intraoral exam are used to determine the best type of surgery; single or double jaw surgery and other surgical options (genioplasty, malarplasty, mandibular angle reduction, etc.) for aesthetic purposes.[10,11]

The orthodontist is the one who decides whether orthodontic treatment is necessary when orthognathic surgery is performed. Consideration is given to tooth movement, anchorage preparation, and the need for extractions. A treatment plan is created in consideration of all diagnostic data and patient concerns. Since temporomandibular joint (TMJ) disorder is more frequent in cases with maxillofacial deformity, a TMJ evaluation is necessary with all patients. Pain, joint noise, range of mandibular movement, mandibular displacement upon mouth opening should all be assessed, and referral to a TMJ specialist if additional evaluation or treatment is necessary (Fig. 3).[4,12]

Surgical treatment objective (STO)

Surgical treatment objective (STO) is the process of performing two-dimensional or three-dimensional virtual orthognathic surgery using lateral cephalograms and CBCT images of patients with a facial skeletal deformity. STO is the basis for diagnosis and planning the treatments of patients who will undergo orthognathic surgery, and STO, based on the prediction of presurgical orthodontic treatment using initial images from lateral cephalograms, is very important as the first step in orthognathic surgical treatment.[7,13]

Surgeons and orthodontists can predict and evaluate the postoperative stability and aesthetic effects of a treatment with STO. STO also informs the patient of the predicted outcome and serves as the basis of dialogue between the patient and treatment team in the preoperative planning stage (Fig. 4). In other words, the direction and goals of presurgical orthodontic treatment can be set through STO, and it is possible to make a plan for functionally and aesthetically successful orthognathic surgery by predicting the changes in facial profile after the maxillomandibular complex has been surgically moved.

Presurgical orthodontic treatment

The goal of presurgical orthodontic treatment is to arrange maxillary and mandibular teeth in each arch precisely so that the dentition and arches are well coordinated at the time of surgery, to move the maxillary and mandibular incisors to the most appropriate anterior, posterior or vertical position, and to adjust arch width for good occlusion.[4,14]

Most orthognathic surgery patients show dental compensation. Therefore, the inclination of maxillary and mandibular incisors should be fully decompensated during the presurgical orthodontic phase, and then the angle and anteroposterior relation between the cranial base and maxillary occlusal plane are determined through surgery to carry out sufficient improvement of the soft tissue profile. However, in this case the maxillary incisors were proclined during presurgical orthodontics due to anterior crowding and we decided to improve the torque during Le Fort I surgery (Figs. 5–8 and Table 1).[15–17]

Arch coordination

During the presurgical orthodontic phase, it is necessary to decide whether to use surgical or orthodontic treatment to resolve the interdental

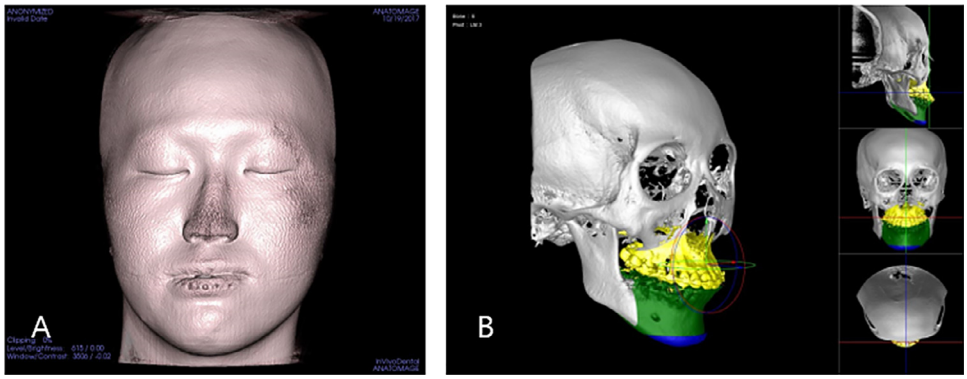

Figure 4. (A) CBCT images were taken and volume rendering of soft tissue was performed. (Anatomage, San Jose, CA, USA). (B) Surgery simulation can be used to inform the patient of postoperative results (Morpheus, Seoul, Korea).

arch width discrepancy between the maxilla and mandible. In cases where the arch width discrepancy is minor and the maxillary arch is wide, discrepancy can be corrected by decreasing the maxillary intermolar width by extracting the premolars, followed by moving the maxillary posterior teeth mesially. In cases where the arch width discrepancy is minor and the maxillary arch width is narrow, expansion could be accomplished using a miniscrew-assisted rapid palatal expander (MARPE) (Fig. 7). If the arch width discrepancy is severe, the intermolar and intercanine width could be corrected by maxillary two-piece or three-piece osteotomy.[18–20]

Figure 5. Pretreatment facial and intraoral photographs of a Class III patient. Compensated maxillary and mandibular incisors were observed.

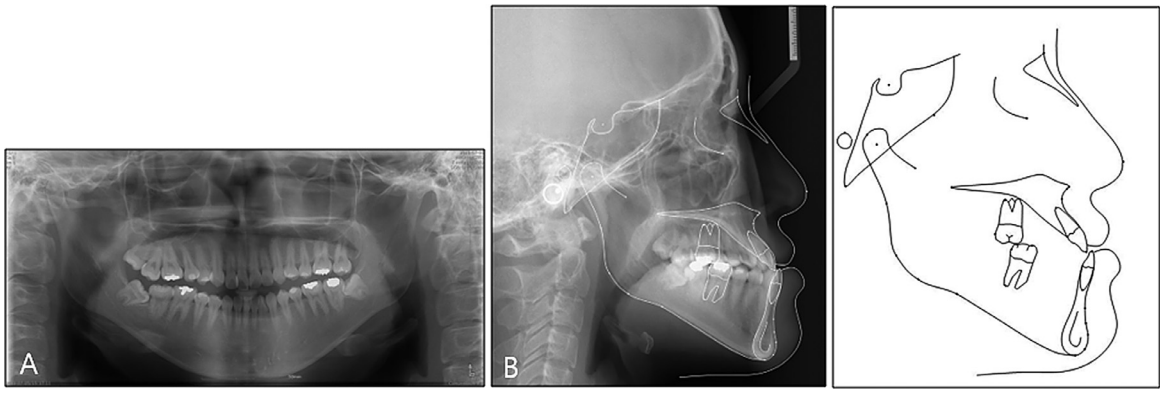

Figure 6. (A) Pretreatment panoramic radiograph. (B and C) Cephalometric tracing using V-ceph software (CyberMed, Inc., Seoul, Korea).

Resolving dentoalveolar compensation

With skeletal Class III malocclusion, the decompensation of lingually inclined mandibular incisors is usually performed without any extractions because the mandibular arch is large. In the maxilla, the decision to extract is determined by the amount of decompensation needed, the inclination of the maxillary incisors, and crowding. In Class III malocclusion, if only maxillary premolars are to be removed, Class I canine relationship and Class II molar relationship will be obtained. In skeletal Class II malocclusion, if lingually inclined maxillary incisors are not fully decompensated, insufficient mandibular advancement results, which then fails to significantly improve the retrognathism. In Class II malocclusion, if only mandibular premolars are removed, Class I canine relationship and Class III molar relationship is obtained.[21–24]

In the case of anterior open bite, there are many cases where the anterior teeth are somewhat elongated because of the compensation function. Therefore, the open bite should not be closed by presurgical orthodontic treatment to maximize the amount of skeletal movement during surgery and to maintain postoperative stability. Patients with skeletal facial asymmetry are often compensated for buccolingual inclination of the maxillary and mandibular posterior teeth depending on the direction of mandibular displacement. Therefore, in the presurgical orthodontic treatment, it is necessary to eliminate the inclination of compensated posterior teeth through torque control and with cross elastics.

Figure 7. A miniscrew-assisted rapid palatal expansion (MARPE) was performed to expand the constricted maxillary arch.

Figure 8. Preoperative facial and intraoral photographs. Decompensated maxillary and mandibular incisors were observed.

The timing of the surgery

During the presurgical orthodontic phase, the goal of the orthodontist should be to ensure that the maxillary and mandibular jaws will be as efficient and stable as possible after surgery. The presurgical evaluations should be done 2–3 months before the surgery and should include arch coordination, dental occlusion, condylar position, and the proper orthodontic appliance should be selected for postoperative skeletal stability. If all conditions are satisfactory, an STO should be performed once more in collaboration with the surgeon so a final decision can be made about the surgical treatment plan (Fig. 9).

Preoperative consultation

Orthognathic surgery has become a predictable and safe treatment option, thanks to the development of anesthesia and surgical techniques, the use of various medicines including antibiotics, airway management, and pain control.[2,25] Orthodontists and surgeons explaining the details of the treatment process to patients is as important as actually doing the treatment. When first counseling a patient and their caregiver, start with an explanation of the incision area and method of surgery. Then, discuss any potential adverse postoperative effects and complications along with the expected time before the patient can return to their normal activities of life. Tell them what they need to know but do not be too serious. On the day before surgery, explain the recovery process, diet, range of motion, and the possibility of facial edema and postoperative depression.[26]

Preoperative patient preparation

Mandatory preparation before surgery includes systemic tests, clinical pathology tests, surgical archwire, occlusal adjustment, autologous transplantation, model surgery and splint fabrication. Orthognathic surgery procedures usually

Table 1. Cephalometric measurements.

Measurement	*Norm*	*Pretreatment*	*Presurgical treatment*	*Posttreatment*
SNA (°)	82.0	85.4	85.4	84.8
SNB (°)	80.0	87.5	86.5	82.1
ANB (°)	2.0	−2.1	−1.1	2.7
Wits (mm)	0.0	−13.2	−11.2	−4.0
SN-MP (°)	32.0	38.1	39.3	39.6
Ramus Height (mm)	44.0	45.1	44.7	41.4
LFH (ANS-Me/N-Me) (%)	55.0	55.4	55.5	54.0
U1-SN (°)	104.0	112.8	120.0	111.2
U1-NA (°)	22.0	27.4	34.7	26.3
U1-NA (mm)	4.0	6.9	7.7	4.6
IMPA (°)	90.0	76.5	85.5	87.1
L1-NB (°)	25.0	23.2	32.1	32.2
L1-NB (mm)	4.0	6.2	8.1	6.4
U1/L1 (°)	131.0	131.5	114.3	118.7
UL-E (mm)	−4.0	−4.3	−3.6	−3.2
LL-E (mm)	−2.0	0.3	1.5	−1.2

take a long time, so it is inevitable that some blood loss may occur at the time of the operation, so it might be necessary to supplement the blood loss. The best way to prepare for this is with an autologous blood transfusion for supplementation. The amount of blood taken from a patient can be up to 1200 to 1500 ml. While single jaw operations usually do not require autologous blood transfusions, but double jaw surgeries often do. The blood should be prepared 3−4 weeks before the surgery, depending on the storage period.[27,28] A surgical stent should be made of synthetic resin and the spatial position of the jaw displacement should be determined and used as a guide for inducing postoperative occlusion.

Single jaw surgery that displaces one jaw uses a single device while double jaw surgery uses more than two devices for the surgery. In particular, if multiple stent devices are needed, they should be constructed with the greatest care to ensure the devices are not distorted. Because of the direct influence splints have on the surgical outcome and stability, it is very important they are made through accurate virtual model surgery. In addition, the surgeon should check for interference by placing a bracket or device in the patient beforehand, and adjust the splint accordingly. The construction of 3D digital guides have been gradually introduced in the process to reduce the errors in model surgery and improve the predictability (Fig. 10).[29−31]

The operation itself

Le Fort I osteotomy is the most common surgical method for correcting maxillary deformities. If only the position of the anterior teeth needs to be corrected and it is not necessary to change the occlusal plane of the maxillary molar area because the molar relationship is already stable or expected to be stable after mandibular surgery, maxillary anterior segmental osteotomy (ASO) can be used. In this case, the segmented anterior maxillary fragment can be moved upward, downward, backward, and rotated. This method can also be an option when the maxilla

Figure 9. (A) Preoperative CBCT images (Anatomage, San Jose, CA, USA) (B) Subjective treatment object (STO) was performed using V-ceph software (CyberMed, Inc., Seoul, Korea).

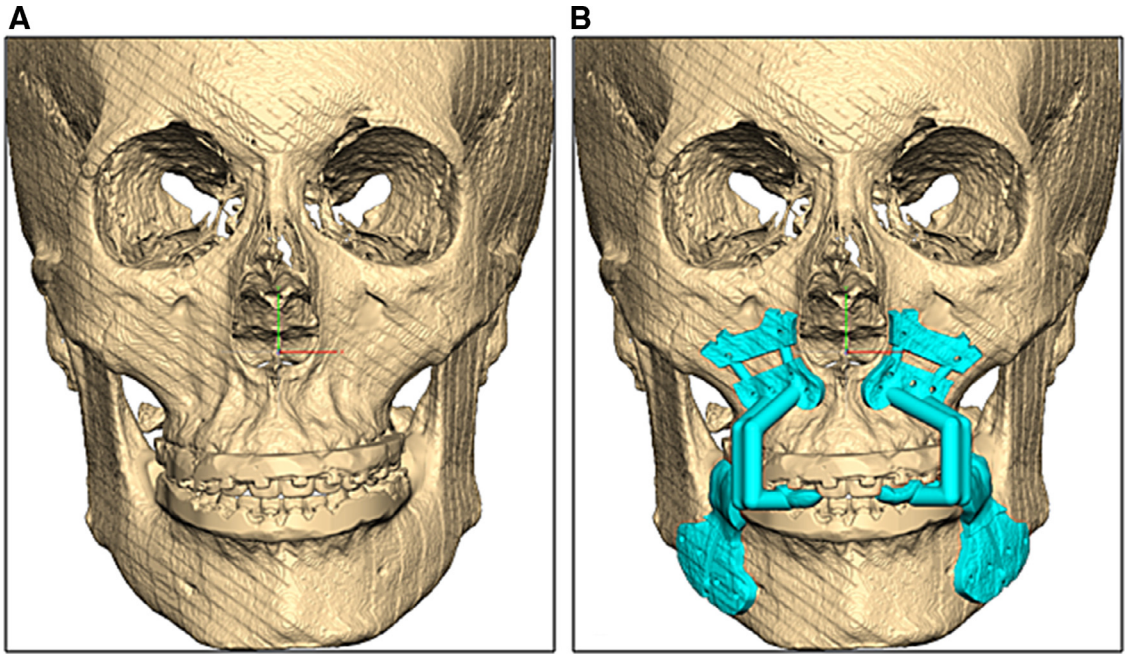

Figure 10. (A) CBCT images after virtual surgery. (B) Patient-customized osteotomy guides designed after virtual surgery (MegaGen, Seoul, Korea).

is overgrown horizontally. The anterior fragment can be moved backward into the space left by the extracted premolars. Also, anterior fragments can be moved downward in an anterior open bite malocclusion, or upward in Class II division 2 cases with severe reverse curve of Spee.

For mandibular surgery to correct a Class III skeletal pattern, sagittal split ramus osteotomy (SSRO) and intraoral vertical ramus osteotomy (IVRO) is a conventional method. SSRO is the most widely used mandibular surgery method because of the excellent healing abilities of the wide contact bony surface between the proximal and distal segments. It is also possible to rotate or move distal segments forward or backward, enabling the procedure to be used in a wide range of applications including mandibular prognathism, mandibular retrognathism, and asymmetry.[32] IVRO is a procedure for correcting the mandible by vertically osteomizing the ramus and superimposing the two segments without fixation; just intermaxillary fixation and physical therapy are used. The absence of fixation during this surgery method makes it simpler than SSRO. Additionally, there's no stress when positioning the mandibular and proximal segment, an added advantage with the IVRO method. Since mandibular segments are positioned without any fixation, this method can also be used for patients with TMJ disease.[33,34] However, IVRO cannot be used for mandibular advancement in patients with mandibular retrognathism and needs longer intermaxillary fixation period than SSRO.

Postoperative patient management

In most cases, in order to prevent serious complications such as airway obstruction after surgery, there is a hospitalization period of 2–3 days for single jaw surgery and 3–5 days for double jaw surgery. For the first 1 to 2 weeks, liquid diets are recommended and soft blended diets can be given for the next two weeks.[35]

Light elastics (1/4 inches, 3oz) are used to induce mandibular teeth to the indentation in the wafer during mandibular opening. Patients are initially advised to use light elastics for an entire day, and then they can reduce application time if the occlusion is good on the wafer. After 1 to 2 weeks, they can remove the elastics for 2 to 3 h a day at meal times.

Figure 11. Posttreatment facial and intraoral photographs. 8 months after surgery, debonding was performed.

Patients should gargle with chlorhexidine for intraoral hygiene management. Generally, they may brush their teeth with a small, soft toothbrush two weeks after the surgery.

Postsurgical orthodontic treatment

If the initial jaw treatment is satisfactory and there is a sufficient range of motion and stability after surgery, then postsurgical orthodontics, the final stage of orthodontic treatment, can be started. Rigid fixation does not cause healing more quickly, but bone segments are more stable from the start, allowing patients to regain early limited function and postsurgical orthodontic treatment can begin after 2–4 weeks.[36]

The postsurgical orthodontic treatment should wait for at least 2 weeks after the surgery since the initial bone and muscle healing, reattachment of bone fragments with the surrounding soft tissue, and adaptation generally requires two weeks' time. However, active postsurgical orthodontic treatment is often initiated around 4 weeks if the patient can open his or her mouth wide enough for treatment. If any doubt arises regarding the postoperative healing, treatment should be further postponed. In particular, careful attention should be given to the timing of postsurgical orthodontic treatment when there is a potential delay in healing. The exact timing of orthodontic treatment should be determined after a consultation with the surgeon if additional attention is required.

With postsurgical orthodontic treatment, regional acceleratory phenomenon (RAP) should be considered. Based on RAP, Liou et al.[37] reported that orthognathic surgery triggers 3–4 months of higher osteoclastic activities and metabolic changes in the dentoalveolus postoperatively, which can potentially accelerate postoperative orthodontic tooth movement.

The total duration of postsurgical orthodontics may require approximately 6 to 10 months to complete (Figs. 11 and 12, and Table).

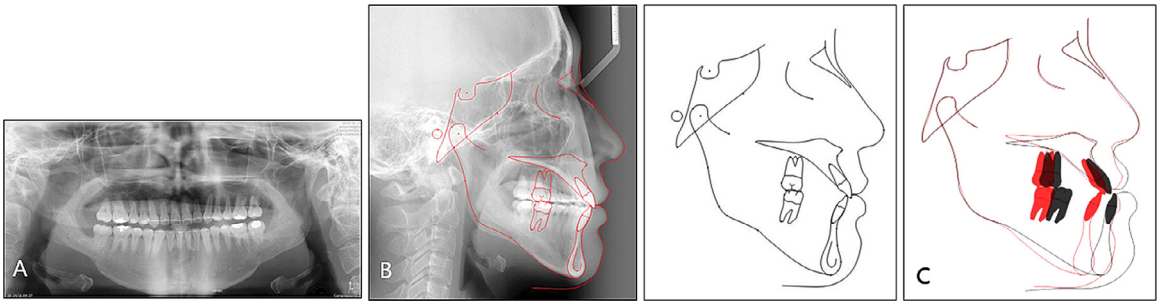

Figure 12. (A) Posttreatment panoramic radiograph. (B) Cephalometric tracing after debonding using V-ceph software (CyberMed, Inc., Seoul, Korea). (C) Cephalometric superimposition. Black, pretreatment; red, posttreatment. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

Conclusion

Orthognathic surgery treatment can produce good results when both function and esthetics are considered. For successful orthognathic surgery, there should be close cooperation between the orthodontist and surgeon. Collaboration should take place from the very start, and there should be an ongoing discussion about the appropriate orthodontic treatment and surgical methods.

References

1. Prabhu J, Cousley RR. Current products and practice: bone anchorage devices in orthodontics. *J Orthod.* 2006;33:288–307.
2. Precious DS, Splinter W, Bosco D. Induced hypotensive anesthesia for adolescent orthognathic surgery patients. *J Oral Maxillofac Surg.* 1996;54:680–683. discussion 683-684.
3. Vig KD, Ellis 3rd E. Diagnosis and treatment planning for the surgical-orthodontic patient. *Dent Clin North Am.* 1990;34:361–384.
4. Tompach PC, Wheeler JJ, Fridrich KL. Orthodontic considerations in orthognathic surgery. *Int J Adult Orthodon Orthognath Surg.* 1995;10:97–107.
5. Hajeer MY, Millett DT, Ayoub AF, Siebert JP. Applications of 3D imaging in orthodontics: part I. *J Orthod.* 2004;31:62–70.
6. Olszewski R, Villamil MB, Trevisan DG, et al. Towards an integrated system for planning and assisting maxillofacial orthognathic surgery. *Comput Methods Program Biomed.* 2008;91:13–21.
7. Choi JY, Song KG, Baek SH. Virtual model surgery and wafer fabrication for orthognathic surgery. *Int J Oral Maxillofac Surg.* 2009;38:1306–1310.
8. Nagasaka H, Sugawara J, Kawamura H, Nanda R. Surgery first" skeletal Class III correction using the skeletal anchorage system. *J Clin Orthod.* 2009;43:97–105.
9. Baek SH, Ahn HW, Kwon YH, Choi JY. Surgery-first approach in skeletal Class III malocclusion treated with 2-jaw surgery: evaluation of surgical movement and postoperative orthodontic treatment. *J Craniofac Surg.* 2010;21:332–338.
10. Vig KD, Ellis 3rd. E. Diagnosis and treatment planning for the surgical-orthodontic patient. *Clin Plast Surg.* 1989;16:645–658.
11. Fattahi T. Aesthetic surgery to augment orthognathic surgery. *Oral Maxillofac Surg Clin North Am.* 2007;19:435–447. vii.
12. Laskin DM. The clinical diagnosis of temporomandibular disorders in the orthodontic patient. *Semin Orthod.* 1995;1:197–206.
13. Proothi M, Drew SJ, Sachs SA. Motivating factors for patients undergoing orthognathic surgery evaluation. *J Oral Maxillofac Surg.* 2010;68:1555–1559.
14. Sabri R. Orthodontic objectives in orthognathic surgery: state of the art today. *World J Orthod.* 2006;7:177–191.
15. Ellis 3rd E, McNamara Jr. JA. Components of adult Class III malocclusion. *J Oral Maxillofac Surg.* 1984;42:295–305.
16. Worms FW, Isaacson RJ, Speidel TM. Surgical orthodontic treatment planning: profile analysis and mandibular surgery. *Angle Orthod.* 1976;46:1–25.
17. Lin J, Gu Y. Preliminary investigation of nonsurgical treatment of severe skeletal Class III malocclusion in the permanent dentition. *Angle Orthod.* 2003;73:401–410.
18. Lee SJ, Kim TW, Nahm DS. Transverse implications of maxillary premolar extraction in Class III presurgical orthodontic treatment. *Am J Orthod Dentofac Orthop.* 2006;129:740–748.
19. Bishara SE, Staley RN. Maxillary expansion: clinical implications. *Am J Orthod Dentofac Orthop.* 1987;91:3–14.
20. Stoelinga PJ, vd Vijver HR, Leenen RJ, Blijdorp PA, Schoenaers JH. The prevention of relapse after maxillary osteotomies in cleft palate patients. *J Craniomaxillofac Surg.* 1987;15:326–331.
21. Capelozza Filho L, Martins A, Mazzotini R, da Silva Filho OG. Effects of dental decompensation on the surgical treatment of mandibular prognathism. *Int J Adult Orthodon Orthognath Surg.* 1996;11:165–180.
22. Johnston C, Burden D, Kennedy D, Harradine N, Stevenson M. Class III surgical-orthodontic treatment: a cephalometric study. *Am J Orthod Dentofac Orthop.* 2006;130:300–309.
23. Proffit WR, Phillips C, Douvartzidis N. A comparison of outcomes of orthodontic and surgical-orthodontic

treatment of Class II malocclusion in adults. *Am J Orthod Dentofac Orthop*. 1992;101:556–565.
24. Ahn HW, Baek SH. Skeletal anteroposterior discrepancy and vertical type effects on lower incisor preoperative decompensation and postoperative compensation in skeletal Class III patients. *Angle Orthod*. 2011;81:64–74.
25. Bentley KC, Head TW, Aiello GA. Antibiotic prophylaxis in orthognathic surgery: a 1-day versus 5-day regimen. *J Oral Maxillofac Surg*. 1999;57:226–230. discussion 230-222.
26. Hagensli N, Stenvik A, Espeland L. Patients offered orthognathic surgery: why do many refrain from treatment. *J Craniomaxillofac Surg*. 2014;42:e296–e300.
27. Marciani RD, Dickson LG. Autologous transfusion in orthognathic surgery. *J Oral Maxillofac Surg*. 1985;43:201–204.
28. Faverani LP, Ramalho-Ferreira G, Fabris AL, et al. Intraoperative blood loss and blood transfusion requirements in patients undergoing orthognathic surgery. *Oral Maxillofac Surg*. 2014;18:305–310.
29. Metzger MC, Hohlweg-Majert B, Schwarz U, Teschner M, Hammer B, Schmelzeisen R. Manufacturing splints for orthognathic surgery using a three-dimensional printer. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod*. 2008;105:e1–e7.
30. Shaheen E, Sun Y, Jacobs R, Politis C. Three-dimensional printed final occlusal splint for orthognathic surgery: design and validation. *Int J Oral Maxillofac Surg*. 2017;46:67–71.
31. Kim J-W, Kim J-C, Jeong C-G, et al. The accuracy and stability of the maxillary position after orthognathic surgery using a novel computer-aided surgical simulation system. *BMC Oral Health*. 2019;19:18.
32. Wolford LM. The sagittal split ramus osteotomy as the preferred treatment for mandibular prognathism. *J Oral Maxillofac Surg*. 2000;58:310–312.
33. Bell WH, Yamaguchi Y, Poor MR. Treatment of temporomandibular joint dysfunction by intraoral vertical ramus osteotomy. *Int J Adult Orthodon Orthognath Surg*. 1990;5:9–27.
34. Hall HD, Nickerson Jr. JW, McKenna SJ. Modified condylotomy for treatment of the painful temporomandibular joint with a reducing disc. *J Oral Maxillofac Surg*. 1993;51:133–142. discussion 143-134.
35. Venugoplan SR, Nanda V, Turkistani K, Desai S, Allareddy V. Discharge patterns of orthognathic surgeries in the United States. *J Oral Maxillofac Surg*. 2012;70:e77–e86.
36. Park JH, Papademetriou M, Kwon Y-D. Orthodontic considerations in orthognathic surgery: who does what, when, where and how. *Semin Orthod*. 2016;22:2–11.
37. Liou EJ, Chen PH, Wang YC, Yu CC, Huang CS, Chen YR. Surgery-first accelerated orthognathic surgery: postoperative rapid orthodontic tooth movement. *J Oral Maxillofac Surg*. 2011;69:781–785.