Interdisciplinary therapy for severe periodontitis with Angle Class II division 1 malocclusion: A case report with 7-year follow-up

Mitsuhiro Iwata, DDS, PhD[a], Atsushi Saito, DDS, PhD[b], Yuko Kuroda, DDS, PhD[c], Takehiro Shinohara DDS, PhD[d], Eiji Tanaka, DDS, PhD[e]

Authors' affiliations and positions

a: Clinical practitioner, Periodontist, Sakura Dental Clinic, Okayama, Japan

b: Professor and Chair, Department of Periodontology, Tokyo Dental College, Tokyo, Japan

c: Clinical practitioner, Kuroda Dental Office, Osaka, Japan

d: Clinical associate, Department of Orthodontics and Dentofacial Orthopedics, Tokushima University Hospital, Tokushima, Japan

e: Professor and Chair, Department of Orthodontics and Dentofacial Orthopedics, Institute of Biomedical Sciences, Tokushima University Graduate School, Tokushima, Japan

All authors certify that this paper is free of conflict of interest.

Correspondence to: Mitsuhiro Iwata

Sakura Dental Clinic, 3-31-10 Ifuku-cho, Kita-ku, Okayama 700-0013, Japan

Tel: +81 862145607

E-mail: sakuradc@ms7.megaegg.ne.jp

ABSTRACT

Background: Previous studies have suggested that occlusal discrepancy is a risk factor contributing to periodontal disease. [1-3] Occlusal discrepancy could increase the risk of infrabony defects. This is a case of a patient with severe periodontitis who exhibited many infrabony defects in the molar region due to malocclusion-induced trauma. Here, we report the 7-year prognosis of the patient after periodontal regenerative and comprehensive orthodontic therapies for functional recovery with implant prosthodontics.

Case Description: A 54-year-old female presented with the chief complaint of masticatory disturbance. In the molar region, significant tooth mobility, deep periodontal pockets, and infrabony defects were observed. She had excessive overjet, resulting in collapse of anterior guidance. Malocclusion was considered to be an exacerbating factor of the infrabony defects. After initial periodontal therapy, we performed periodontal regenerative therapy in the mandibular molar regions. We carefully placed implants in a position in the maxillary molar region that would ensure an appropriate anterior dental relationship after orthodontic treatment. Comprehensive orthodontic treatment was subsequently performed using implants as anchoring units. Then, definitive surgery was performed on the mandibular molars before placing the final prosthesis. A favorable periodontal condition and a stable occlusion have been maintained for the 7-year post-treatment period.

Practical Implications: Comprehensive and interdisciplinary treatment enables stable occlusion and establishment of periodontal tissue and peri-implant tissues with high cleansability, even in patients with severe periodontitis and malocclusion. In the present case, a favorable long-term treatment outcome can be expected.

Key words: interdisciplinary therapy; occlusal trauma; periodontal regenerative therapy; implant-anchored orthodontic treatment; dental implant

Previous studies have found that occlusal discrepancy is a risk factor contributing to periodontal disease.[1-3] As periodontitis may cause deep infrabony defects and/or the loss of teeth, there may be an absence of stable anchorage teeth, and thus it may be difficult to accurately move the teeth of patients suffering from severe periodontitis and malocclusion. Occlusal trauma aggravates the condition and may lead to further loss of attachment, making it difficult to provide orthodontic treatment for an appropriate occlusal relationship.

However, if malocclusion is a factor that contributes to the progression of infrabony defects, periodontal surgery without first treating the malocclusion may make the prognosis of the surgery uncertain, and will additionally hamper long-term stability. When implant prostheses are applied to an edentulous region, if the malocclusion is not improved, there is a possibility of various mechanical problems associated with the delivered prostheses.[4] Therefore, improvement of the occlusion is essential to obtain a stable treatment result when using implant prosthetics and regenerative therapies to treat patients with severe periodontitis and malocclusion. This type of treatment requires close communication and careful coordination among specialized fields including orthodontics, periodontics, and prosthodontics, and detailed planning of the appropriate treatment sequence for a favorable long-term result. Here, we report a 7-year follow-up of a patient with severe periodontitis and an Angle Class II division 1 malocclusion. An appropriate occlusal relationship, a stable periodontal tissue environment, and favorable esthetic results were obtained through periodontal regenerative therapy and implant-anchored orthodontic treatment by carefully coordinating between specialized fields to implement a comprehensive therapeutic plan.

Case Report

Written informed consent was obtained from the patient for inclusion in this case report.

A systemically healthy, non-smoking, 56-year-old woman presented with the chief complaint of a chewing disorder. Her facial profile was convex, with protrusion of the upper and lower lips and an almost symmetrical frontal view. Molar relationships were Angle Class II bilaterally. Overjet and overbite were 7.5 mm and 4.0 mm, respectively, and there was no contact between the anterior teeth in the intercuspal position (Fig. 1,2A). Although her initial plaque control record was relatively good, some teeth recorded a probing depth exceeding 10 mm, and tooth mobility was grade 2–3 in almost all molars (Table 1). The patient had a routine clenching habit. A panoramic radiograph showed severe vertical infrabony defects, mainly in the molars. (Fig.1). Cephalometric analysis, when compared with the Japanese norm, showed a skeletal Class II jaw-base relationship (ANB, 5.8°). The maxillary incisors were labially inclined (U1-SN, 112.5°), but the mandibular incisors showed an average inclination (L1-mandibular plane, 97.9°), resulting in a decreased interincisal angle (110.9°) (Table 2).

The patient was diagnosed with an Angle Class II division 1 occlusion and generalized severe chronic periodontitis. The treatment objectives were to (1) achieve appropriate anterior guidance to reduce the occlusal trauma, and (2) obtain a healthy periodontal environment with high cleansability.

After initial periodontal therapy, the prognosis of #3, #5, #13–15, #17 and #20 was judged to be hopeless because of excessive tooth mobility and significant bone loss. We planned to restore the upper molar region with an implant prosthesis. Preservation of #29–31 was deemed possible by performing periodontal regenerative therapy. The predictability of regenerative therapy and the long-term prognosis of implant prostheses seemed uncertain without improving the malocclusion. Therefore, an interdisciplinary treatment plan was formulated to gain appropriate anterior guidance, including comprehensive orthodontic treatment (Fig. 3). We prepared a setup model to plan the retraction of the anterior teeth and to determine implant placement positions in the maxilla for appropriate anterior guidance (Fig. 2B). The upper anterior teeth were to be

retracted using dental implants placed in precise positions (determined by referring to the setup model) as anchoring units in order to establish appropriate anterior guidance. Finally, metal-ceramic prosthetic devices were to be inserted to establish a stable posterior occlusal relationship.

As the treatment alternatives, several procedures were explored to achieve an acceptable occlusion. Use of a removable partial denture for prosthetic restorations without orthodontic treatment might shorten the total treatment period; however, chewing ability could not be expected to improve significantly. Additionally, gingival pain caused by the denture and breakdown of the prosthesis were predicted.

If implant prostheses were applied to the lower right molar region, as in the maxillary molars, without preserving the molar teeth, a temporary improvement in masticatory function could be expected. However, occlusal overload to the prosthetic devices would be likely because of the loss of anterior guidance, causing chipping of ceramic restorations and/or mechanical problems with the implant fixtures.

Taking these factors into consideration, it was deemed that orthodontic treatment to establish the anterior occlusion was essential. Mandibular retrusion was recognized by a cephalometric radiograph and surgical mandibular advancement was found to be ideal in order to obtain an appropriate inclination angle for the lower anterior teeth. However, that treatment plan was refused by the patient due to her age. Because deep infrabony defects and severe tooth mobility had been observed in the bilateral lower second premolars, extraction of these teeth and closure of these spaces may have been one option to establish a stable occlusion. If this treatment had been applied, there would have been increased movement of the molars with the deep infrabony defects, and regenerative therapy would have become unpredictable. Additionally, the upper anterior teeth would have needed to be significantly retracted, resulting in further posterior movement of the patient's upper lip. Considering the patient's age, we thought that a sufficient

esthetic outcome could be obtained without too much posterior retraction. We therefore determined that the lower arch should be treated without extracting the premolars, even if a slight overjet remained.

A timeline of the interdisciplinary treatment plan is shown in Figure 3. First, regenerative therapy with an enamel matrix derivative (EMD, Emdogain® Gel, Straumann, Basel, Switzerland) and demineralized freeze-dried bone allograft (DFDBA OraGRAFT®, LifeNet Health, Virginia Beach, VA, USA) was performed for #18 and #29–31 (Fig. 4D-F).[5,6] These teeth were fixed with provisional restorations. Because only 2–3 mm of vertical bone height was noted in the upper molar region by computed tomography (CT), lateral approach sinus augmentation therapy was performed using a bone graft (Bio-Oss®, Geistlich, Wolhusen, Switzerland) in a staged approach (Fig. 4A).[7-9] Twelve months later, implants were placed at positions #3, #13 and #14 in accordance with the setup-model-based surgical stent (Fig. 4B,C).

At 18 months after the regenerative therapy, 0.022-in slot preadjusted edgewise appliances were placed on the lower arch, followed by leveling and alignment with nickel-titanium archwires (Fig. 5A). Secondary surgery was performed following integration of the maxillary implant; then, using the upper molar dental implants as anchoring units, the upper anterior teeth were distalized with closing-loop mechanics and a stainless steel archwire (Fig. 5B). To obtain an appropriate interincisal angle and overbite of the anterior teeth, the upper anterior teeth were further retracted while being intruded with a T-loop. In the lower arch, the space of #20 was secured using an open coil, while improving the Spee curve. Next, #4 was moved mesially to position #5 (Fig. 5C). When appropriate space was confirmed at #4, additional implants were placed in positions #4 and #20. After removal of the edgewise appliances, a wraparound type retainer was placed on the upper arch, and a lingual bonded retainer was applied to the lower dentition. The total active orthodontic treatment period was 21 months (Fig. 3).

In the following reevaluation, the probing depths of #29–31 were reduced to around 4 mm. Periapical radiographs also showed a marked improvement in the osseous defects, although only a slight difference was found in the marginal bone level. The keratinized gingiva surrounding the teeth had insufficient width and abnormal adhesion of the frenulum was found; therefore, osseous surgery and free gingival grafting were performed (Fig. 4I).[10,11] The osseous defects at #29 and #30 improved (Fig. 4G,H). Reevaluation was conducted 3 months later, following the resective therapy, and practically all regions showed probing depths ≤ 3 mm. Metal-ceramic prosthetic devices were placed at #3–5, #12–14, #18–20, and #29–31. A night guard was fitted and maintenance was conducted every 3 months.

The post-treatment facial photographs show that an ideal facial profile and attractive smile were achieved (Fig. 6). The occlusion was much more stable, and acceptable intercuspation of the teeth was achieved with Class I canine and molar relationships (Fig. 2C). Additionally, all teeth showed probing depths ≤ 3 mm and no mobility (Table 1).

In the panoramic radiograph, bone levels around the lower right molar were aligned and the bone around other teeth and implants was also stable. Dental implants and correct root paralleling can be seen (Fig. 6). Post-treatment cephalometric evaluation still showed a Class II jaw-base relationship (ANB, 5.5°) and a slight decrease of vertical dimension of occlusion (SN-MP, 37.9°). The inclination of the upper incisors had improved appropriately (U1-SN, 105.9°) and an acceptable interincisal relationship was also maintained (Table 2). No symptoms of temporomandibular disorders were observed throughout the active orthodontic treatment period.

At 8-year post-retention and 7-year post prosthodontic treatment, the occlusion was stable, and a good facial profile was also retained (Fig. 7). The periodontal condition was stable. A panoramic radiograph showed that bone levels around the teeth and implants were stable (Fig.7).

The cephalometric analysis and superimposition of pre-treatment, post-treatment, and post retention showed little change (Fig. 8, Table 2).

DISCUSSION

We treated a patient with severe periodontitis accompanied by malocclusion through a comprehensive treatment program that included periodontal, orthodontic, and implant therapies. As a result, improvements in function, esthetics and periodontal tissue stability have been achieved. Oral hygiene conditions were adequate, though she had habitual clenching. In addition, as the proper anterior guidance had been lost, chronic periodontitis was caused, resulting in occlusal trauma that caused deep angular bony defects and severe tooth mobility in the molar region. If #29–31 had been extracted and replaced with implants, the absence of anterior guidance would probably have resulted in damage to the ceramic portions of the superstructure,[4,12,13] and the bone surrounding the implants could have been affected.[12,14,15] Preservation of the maxillary molars was not possible because of furcation involvement and the degree of tooth mobility; however, the mandibular molars were able to be preserved by periodontal tissue regeneration. Additionally, an improvement of the malocclusion was considered critical to ensure the success of periodontal and implant therapies. Using a setup model, the positions of the molar implants were carefully chosen to optimize the anterior guidance. The orthodontic treatment was performed without extracting any premolars, with the aim of limiting mesiodistal movement as much as possible in the mandibular molar region where the regenerative therapy had been performed.

A vital question to be considered is whether orthodontic treatment or regenerative therapy should be undertaken first. It has been reported that if a tooth is moved in the direction of an intrabony periodontal defect, and if inflammation is sufficiently controlled, there would be no loss of connective tissue attachment or even renewed attachment.[16] Another study found that

intrusive movements, after proper periodontal surgical therapy, can positively modify both the alveolar bone and the soft periodontal tissues.[17] Therefore, it seems that orthodontic movement of teeth with infrabony defects can achieve satisfactory treatment results without regenerative therapy, but only if sufficient debridement is applied to the subgingival pockets. Another study reported that if periodontal tissue around an infrabony defect is inflamed, orthodontic movement of the teeth will result in additional loss of attachment.[18] Thus, the infrabony defect could increase in size as a result of insufficient debridement and/or poor plaque control. Nemcovsky et al.[19] researched whether orthodontic tooth movement influences periodontal healing, by creating bony defects adjacent to molars and then orthodontically moving the teeth. They concluded that orthodontic treatment could not completely avoid the formation of long epithelial attachments; therefore, they suggest that periodontal regenerative therapy should be performed prior to orthodontic tooth movement. For these reasons, if inflammation is sufficiently controlled, anterior teeth with pathological tooth migration can be treated orthodontically without regenerative therapy, because dental plaque control is easier in the anterior region and excessive occlusal force is not normally applied to the anterior teeth. However, molar teeth with infrabony defects caused by occlusal trauma may be subjected to excessive traumatic force during orthodontic tooth movement, in addition to the difficulty of controlling dental plaque. Therefore, it is preferable to undertake regenerative therapy before orthodontic treatment when possible.

There has been considerable discussion on the timing of periodontal regenerative therapy and orthodontic therapy,[20–23] and one report recommended that commencing orthodontic therapy as early as 2 weeks after regenerative therapy is beneficial for periodontal tissue regeneration.[23] Although commencing orthodontic therapy shortly after regenerative therapy was possible in this case, we decided to wait at least 6 months after surgery before applying orthodontic forces to the teeth where the regenerative therapy was performed. This was because the affected molar region was subjected to strong occlusal forces. By not applying orthodontic force until the attachment

had regenerated to some extent, we aimed to avoid damage resulting from occlusal trauma. Sufficient bone regeneration was confirmed by re-entry surgery, and physiological bone formation was obtained by conducting additional osseous surgery. Anterior guidance was achieved and trauma to the molar region was reduced, resulting in a functionally stable outcome. Additionally, the esthetic outcome, including the facial features, was favorable. During the 7 years of maintenance, the patient's clinical condition has been uneventful, and thus a favorable and further long-term prognosis can be expected.

In conclusion, a patient with Angle Class II division 1 malocclusion with severe periodontitis was treated through close collaboration among specialized fields to formulate a comprehensive treatment plan. As a result, functionality, esthetics, and cleansability of the periodontal tissues were established and mid-term stability has been maintained. Maxillary molar implants were accurately placed in positions that provided appropriate anterior guidance. Anterior guidance was established through efficient retraction of the anterior teeth using molar implants as anchors.

ACKNOWLEDGMENTS

The authors would like to thank late Dr.Shingo Kuroda for his great support provide to us in the course of treatment for our patients. Without his efforts, we would never have this opportunity to complete this manuscript.

REFERENCES

1. Nuun ME, Harrel SK. The effect of occlusal discrepancies on periodontitis. I. Relationship of initial occlusal discrepancies to initial clinical parameters. J Periodontol 2001;72(4):485-494.
2. Harrel SK, Nuun ME. The effect of occlusal discrepancies on periodontitis. II. Relationship of occlusal treatment to the progression of periodontal disease. J Periodontol 2001;72(4):495-505.
3. Branschofsky M, Bekler T, Schafer R: Secondary trauma from occlusion and periodontitis. Quintessense Int 2011;42(6):515-522.
4. Kinsel RP, Lin D. Retrospective analysis of porcelain failures of metal ceramic crowns and fixed partial dentures supported by 729 implants in 152 patients: Patient-specific and implant-specific predictors of ceramic failure. J Prosthet Dent 2009;101(6):388-394.
5. Rosen PS, Reynolds MA. A retrospective case series comparing the use of demineralized freeze-dried bone allograft and freeze-dried bone allograft combined with enamel matrix derivative for the treatment of advanced osseous lesions. J Periodontol 2002;73(8):942-949.
6. Ogihara S, Tarnow DP. Efficacy of enamel matrix derivative with freeze-dried bone allograft or demineralized freeze-dried bone allograft in intrabony defects: a randomized trial. J Periodontol 2014;85(10):1351-1360.
7. Fugazzotto PA. Augmentation of the posterior maxilla: A proposed hierarchy of treatment selection. J Periodontol 2003;74(11):1682-1691.
8. Wallace SS, Froum SJ, Cho SC, Elian N, Monteiro D, Kim BS, Tarnow DP. Sinus augmentation utilizing anorganic bovine bone (Bio-Oss) with absorbable and nonabsorbable membranes placed over the lateral window: histomorphometric and clinical analyses. Int J Periodontics Restorative Dent 2005;25(6):551-559.

9. Hsu YT, Wang HL. How to Select Replacement Grafts for Various Periodontal and Implant Indications. Clin Adv Periodontics 2013;3:167-179.

10. Kramer GM. The case for osteotomy - A time-tested therapeutic modality in selected periodontitis sites. Int J Periodontal Rest Dent 1995;15(3):228-237.

11. Nevins M. Attached gingiva - Mucogingival therapy and restorative therapy. Int J Periodontal Rest Dent 1986;6(4):9-27.

12. Sheridan RA, Decker AM, Plonka AB, Wang HL. The Role of Occlusion in Implant Therapy: A Comprehensive Updated Review. Implant Dent 2016;25(6):829-838.

13. Paraspyridakos P, Chen CJ, Chuang SK, Weber HP, Gallucci GO. A systematic review of biologic and technical complications with fixed implant rehabilitations for edentulous patients. Int J Oral Maxillofac Implants 2012;27(1):102-110.

14. Isidor F. Loss of osseointegration caused by occlusal load of oral implants - A clinical and radiographic study in monkeys. Clin Oral Impl Res 1996;7(2):143-152.

15. Miyata T, Kobayashi Y, Araki H, Ohto T, Shin K. The influence of controlled occlusal overload on peri-implant tissue. Part 3: A histologic study in monkeys. Int J Oral Maxillofac Implants 2000;15(3):425-431.

16. Gerace TF, Nevins M, Crossetti HW. Reattachment of the periodontium following tooth movement into an osseous defect. Int J Periodontics Restorative Dent 1990;10(3):185-197.

17. Cardaropoli D, Re S, Corrente G, Abundo R. Intrusion of migrated incisors with infra bony defects in adult periodontal patients. Am J Orthod Dentofacial Orthop 2001;120(6):671-675.

18. Wennström JL, Stokland BL, Nyman S, Thilander B. Periodontal tissue response to orthodontic movement of teeth with infra bony pockets. Am J Orthod Dentofacial Orthop 1993;103(4):313-319.

19. Nemcovsky CE, Sasson M, Beny L, Weinreb M, Vardimon AD. Periodontal healing following orthodontic movement of rat molars with intact versus damaged periodontia towards a bony defect. Eur J Orthod 2007;29(4): 338-344.

20. Ghezzi C, Masiero S, Silvestri M, Zanotti G, Rasperini G. Orthodontic treatment of periodontally involved teeth after tissue regeneration. Int J Periodontics Restorative Dent 2008;28(6):559-567.

21. Corrente G, Abundo R, Re S, Cardaropoli D, Cardaropoli G. Orthodontic movement into infrabony defects in patients with advanced periodontal disease: a clinical and radiological study. J Periodontol 2003;74(8):1104-1109.

22. Ogihara S, Marks MH. Enhancing the regenerative potential of guided tissue regeneration to treat an intrabony defect and adjacent ridge deformity by orthodontic extrusive force. J Periodontol 2006;77(12):2093-2100.

23. Cardaropoli D, Re S, Manuzzi W, Gaveglio L, Cardaropoli G. Bio-Oss collagen and orthodontic movement for the treatment of infrabony defects in the esthetic zone. Int J Periodontics Restorative Dent 2006;26(6):553-559.

FIGURE LEGEND

Figure 1 Pretreatment facial and intraoral photographs, lateral cephalogram, and panoramic radiograph.

Figure 2 A. Pretreatment dental cast. B. Setup model. C. Posttreatment dental cast.

Figure 3 Schematic illustration and timeline of interdisciplinary treatment. White numbers indicate treatment duration (in months) after the start of treatment.

Figure 4 Oral photographs of the implant surgery and periodontal surgery: A. A sinus elevation with bone graft (Bio-Oss®) was performed with a staged approach. B, C. Twelve months later, implants were placed in position #13 and #14 in accordance with the surgical stent based on the setup model. Minor guided bone regeneration was performed simultaneously. D-F. Regenerative therapy for #29–31 was performed using enamel matrix derivative solution and demineralized freeze-dried bone allograft. G, H. The osseous defect at #29 and #30 was improved, and bony tissue regeneration was observed at the re-entry surgery. I. Osseous surgery at #29–31 was performed to correct slight differences in the bone level. A free gingival graft was placed at #29–31 to gain attached gingiva.

Figure 5 Treatment progress of orthodontic treatment. A. Orthodontic treatment of the mandible was initiated 18 months after regenerative therapy, starting with leveling and alignment with nickel-titanium archwires. B. Using upper molar dental implants as anchoring units, the upper anterior teeth were distalized with closing-loop mechanics and a stainless steel archwire. C. To obtain an appropriate interincisal angle and

overbite, the upper anterior teeth were further retracted while being intruded. Next, #4 was moved mesially to position #5.

Figure 6 Post-treatment facial and intraoral photographs, lateral cephalogram and panoramic radiograph.

Figure 7 Seven-year post-treatment facial and intraoral photographs, lateral cephalogram and panoramic radiograph.

Figure 8 Cephalometric tracings at pretreatment (black line), posttreatment (red line), and 7-year retention (green line) superimposed on the sella-nasion plane at sella.

Table 1 Periodontal examination at baseline, posttreatment and posttreatment after 7 years. The red-colored numbers show the bleeding on probing.

Table 2 Cephalometric summary.

Fig.1

Fig.2

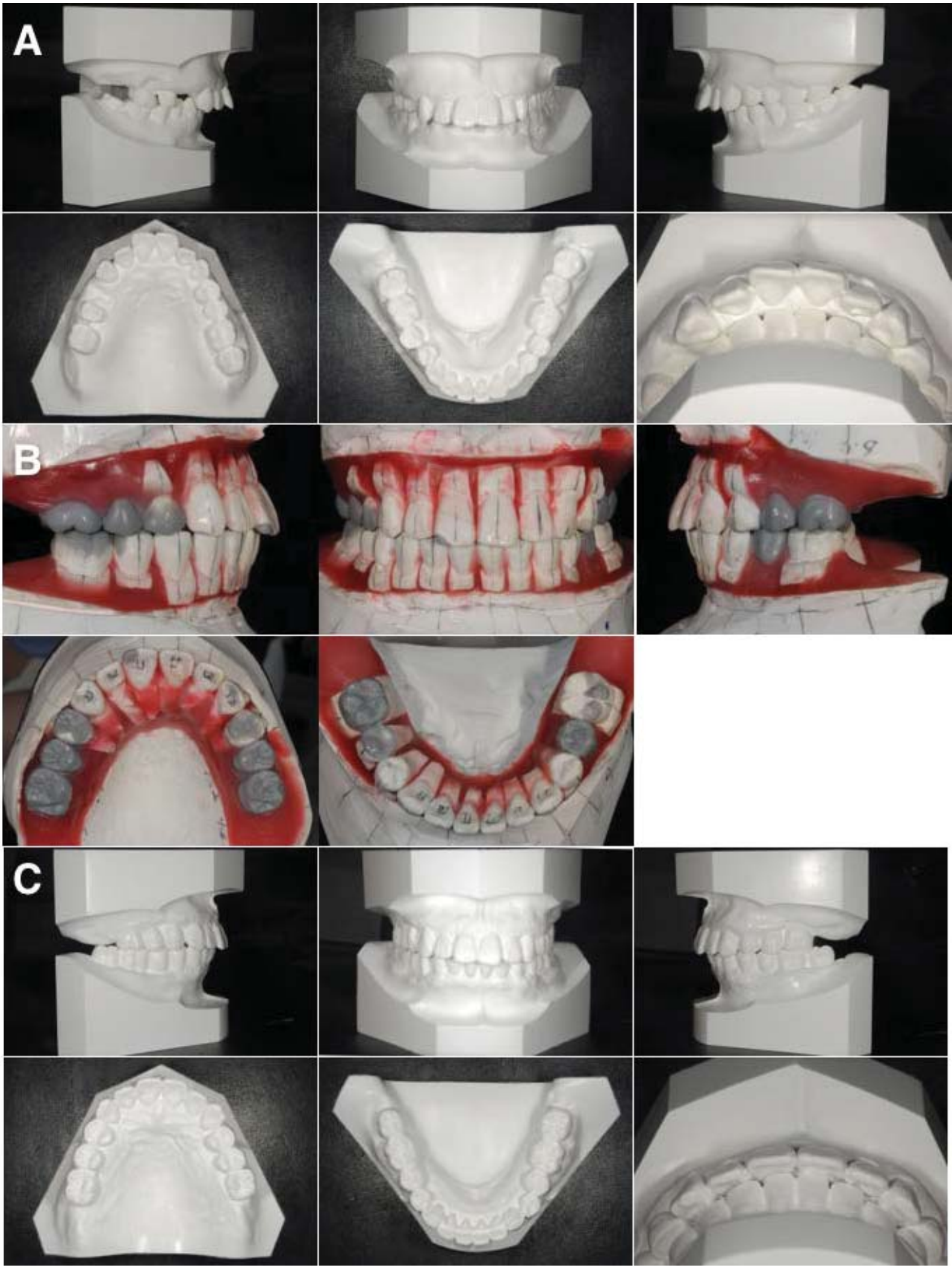

Fig.3

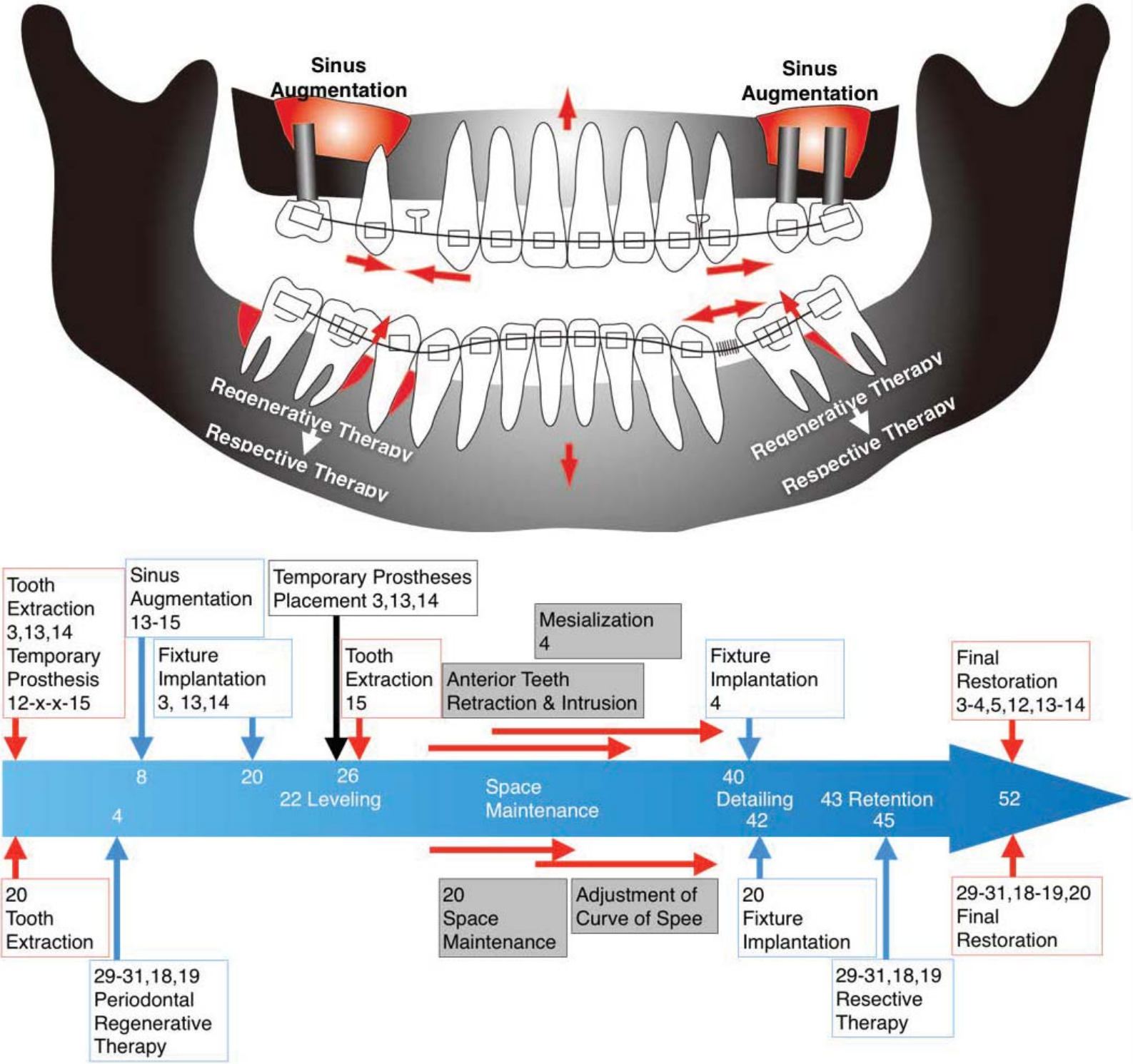
Sinus Augmentation
Sinus Augmentation
Regenerative Therapy
Respective Therapy
Regenerative Therapy
Respective Therapy
Tooth Extraction 3,13,14 Temporary Prosthesis 12-x-x-15
Sinus Augmentation 13-15
Fixture Implantation 3, 13,14
Temporary Prostheses Placement 3,13,14
Tooth Extraction 15
Mesialization 4
Anterior Teeth Retraction & Intrusion
Fixture Implantation 4
Final Restoration 3-4,5,12,13-14
4
8
20
26
22 Leveling
Space Maintenance
40
Detailing
42
43 Retention
45
52
20 Tooth Extraction
29-31,18,19 Periodontal Regenerative Therapy
20 Space Maintenance
Adjustment of Curve of Spee
20 Fixture Implantation
29-31,18,19 Resective Therapy
29-31,18-19,20 Final Restoration

Fig.4

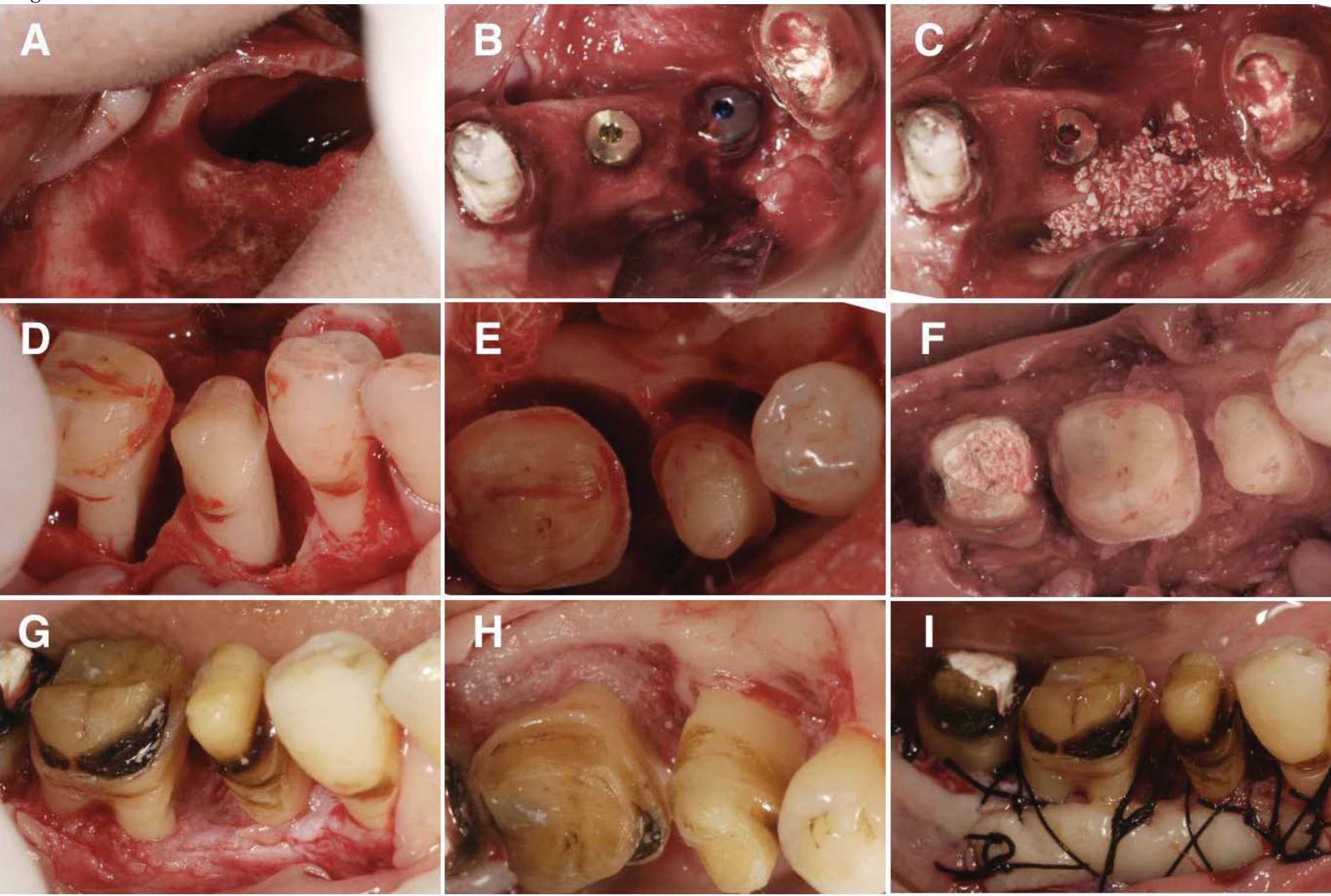

Fig.5

Fig.6

Fig.7

Fig.8


Superimposed on Sella-Nasion plane at Sella
Pretreatment
Posttreatment
Post retaintion

Table_1

Baseline

B				3	4	9	8	3	4				2	1	2	2	1	1	2	1	2	2	2	2	2	2	3	3	1	2	1	2	2	3	2	8	6	6	6	4	3	8
P				4	3	10	8	6	3				2	3	6	2	2	2	2	2	3	2	2	2	2	2	3	3	2	4	2	2	4	2	3	8	8	4	6	8	4	8
M					2			1						0			0			1			1			1						1			2			3			3	
	2			3			4			5			6			7			8			9			10			11			12			13			14			15		
	31			30			29			28			27			26			25			24			23			22			21			20			19			18		
M		3			2			3			1			0			0			0			0			1			1			1			3			1			1	
L	8	6	5	4	6	8	4	8	10	4	2	2	2	1	2	2	1	2	2	1	1	1	1	2	1	2	2	2	1	3	2	2	3	10	6	4	6	8	4	4	4	6
B	10	2	2	4	5	8	4	2	6	3	1	3	2	2	2	2	2	2	2	1	2	3	1	2	2	1	2	2	1	3	2	1	3	8	6	4	3	2	4	6	2	2

Posttreatment

B										3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	2	2	2	2	2	2	2									
P										2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2									
M											0			0			0			1			1			1			0			0										
	2			3			4			5			6			7			8			9			10			11			12			13			14			15		
	31			30			29			28			27			26			25			24			23			22			21			20			19			18		
M		0			0			0			0			0			0			0			0			0			0			0						0			0	
L	3	2	2	2	2	3	2	2	2	2	2	2	2	2	2	3	2	3	3	2	3	3	2	3	3	2	3	3	3	2	2	2	3				3	2	2	2	2	2
B	3	2	2	2	3	3	2	2	2	2	1	2	2	2	2	3	2	3	3	1	2	2	1	3	3	1	3	3	1	2	2	2	3				2	3	3	2	2	2

Posttreatment after 7 yrs

B				2	1	3	2	1	3	3	1	3	3	1	2	2	2	2	2	2	2	2	1	2	2	2	2	2	2	2	2	1	3	2	2	2	2	2	2			
P				3	1	2	3	2	2	3	3	4	3	2	3	2	2	3	3	2	3	3	2	3	2	2	3	2	3	3	3	3	3	2	2	2	3	3	3			
M					0			0			0			0			0			1			1			1			0			0			0			0				
	2			3			4			5			6			7			8			9			10			11			12			13			14			15		
	31			30			29			28			27			26			25			24			23			22			21			20			19			18		
M		0			0			0			0			0			0			0			0			0			0			0			0			0			0	
L	4	2	3	3	2	4	3	2	4	3	2	2	2	1	2	2	1	2	2	1	2	2	2	2	2	1	2	2	2	2	2	1	2	2	1	2	3	3	3	3	2	3
B	4	2	2	2	2	2	3	3	4	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	1	2	3	2	2	3	2	4

Table_2

	Japanese Norm Adult-female	S.D.	Baseline	Posttreatment	Posttreatmet after 7 years
SNA	80.8	3.61	81.7	81.7	81.7
SNB	77.9	4.54	75.8	76.1	75.9
ANB	2.8	2.44	5.8	5.5	5.8
SN-Mp	37.1	4.64	39.7	37.9	38.4
U1-SN	105.9	8.79	112.5	105.9	105.6
L1-Mp	93.4	6.77	97.9	103.4	103.7
Interincisal angle	123.6	10.64	110.9	111.9	112.3
Occlusal plane	16.9	4.4	22.7	25.3	25.5