Class III Malocclusion with an Atrophic Edentulous Ridge Treated with Autotransplantation, Lower First Molar Extraction and Space Closure

Abstract

Diagnosis: *A 19-year-10-month-old female with chief complaints of crowding and missing teeth presented for a second opinion. Clinical examination revealed a straight profile, 3° G-Sn-Pg' facial convexity, and high mandibular plane angle (SN-MP 35°). The occlusion was Class III, crowded anterior segments, missing left maxillary first and second premolars, and an edentulous atrophic ridge. All third molars were present and the lower right first molar (LR6) was compromised with poor tooth structure and failed endodontics. The ABO Discrepancy Index (DI) was 20.*

Etiology*: Class III dentofacial malocclusion was due to genetics and environmental factors. The absence of both upper left premolars had resulted in the mesial migration of her upper left molars and a residual atrophic edentulous ridge.*

Treatment*: The emphasis was on a conservative treatment plan that preserved healthy teeth. The right upper second premolar (UR5) was endodontically treated and autotransplanted into the edentulous atrophic site (UL4). Both mandibular first molars were extracted and the adjacent second and third molars were protracted to close space and substitute for the first molars.*

Outcome*: The autotransplanted premolar healed successfully, crowding was corrected, and the dentition was well aligned with Class I canine and Class II molar relationships. The ABO Cast Radiograph Evaluation (CRE) was 16. (J Digital Orthod 2019;56:4-20)*

Key words:
Autotransplantation, Class III malocclusion, wisdom teeth replacement

History

A 19-year-10-month-old female presented with the chief complaints of crowding and missing premolars. The pre-treatment facial photographs (*Fig. 1*) showed a straight profile with 3° facial convexity (*G-Sn-Pg'*). Her upper left first and second premolars were missing leaving a severe atrophic ridge (*Figs. 2 and 3*). Brackets were bonded on the upper arch by a previous orthodontist (*Fig. 2*), but her parents wanted a second opinion because they were not satisfied with the treatment plan.

Intra-oral examination revealed missing upper left premolars, severe atrophic ridge (*Fig. 4*), Class III canine relationship, and a compromised lower right first molar. The maxillary dental midline was shifted 1mm to the left of the facial midline. As outlined in Table 1, the previous orthodontist had proposed Plan A: extract both mandibular wisdom teeth and the maxillary right wisdom tooth. Three temporary anchorage devices (*TADs*) were proposed: bilateral in the mandibular buccal shelf regions, and in the right maxillary infrazygomatic crest. A dental implant was planned for the edentulous space which was deemed a viable option because

Dr. Derek Teng-Kai Yang,
Orthodontist, E-Da Hospital (Upper left)

Dr. Po-Jan Kuo,
Periodontist, Jing-Jong Lin Orthodontic Clinic (Upper center)

Dr. Nancy Nie-Shiuh Chang,
Periodontist, Jing-Jong Lin Orthodontic Clinic (Upper right)

Dr. John Jin-Jong Lin,
Examiner, Journal of Digital Orthodontics
Director, Jin-Jong Lin Orthodontic Clinic (Lower left)

Dr. W. Eugene Roberts,
Editor-in-chief, Journal of Digital Orthodontics (Lower right)

longterm implant success is reported to be up to 94.6%.[1] However, the patient and her parents wanted to preserve as many healthy teeth as possible. According to the family concerns, Plan B was proposed: autotransplant the UR5 to restore the edentulous space (*UL4*), extract both lower first molars, and close space to produce an intact lower arch (*Table 1*).

Fig. 1: Pre-treatment facial photographs

Fig. 2: Pre-treatment intraoral photographs

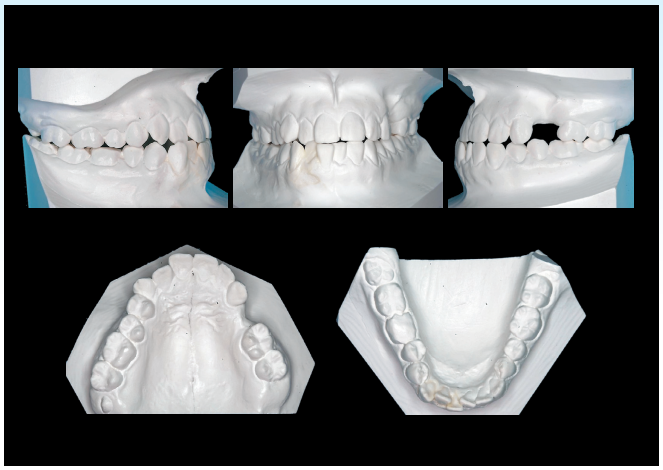


Fig. 3: Pre-treatment dental models (casts)

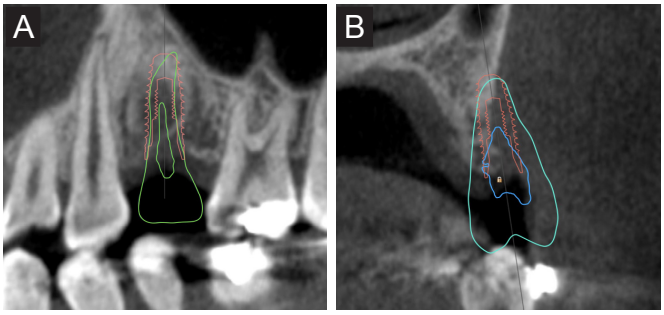


Fig. 4:

A. Sagittal slice showing the similar mesio-distal dimension of the virtual dental implant (red line) and donor tooth (green line) at the alveolar bone crest level.

B. Coronal slice from the radiographic examination showing complete loss of the buccal plate.

	Tx Plan A	Tx Plan B
Dental Implant	1	No
46 Dental Crown	Yes	No
Extraction	18, 38, 48	15 for 24, 36, bad 46
Distalization	17, 37, 47	No
Screws	3	No
Re-endo	46	No
Bone Graft	Yes	Yes
Waste of 18	Yes	No

Table 1: Plan A and Plan B comparison.

CBCT images of the virtual dental implant (*Ø4.3mm x 11.5mm*) with a crown is shown with a red outline. An imported STL file was used to replicate the donor tooth (*green line*) (*Fig. 4*). The buccal-palatal width of the donor tooth (*8.3mm*) was greater than the dental implant (*4.3mm*). A horizontal bone augmentation procedure to produce a ridge >5mm was essential for dental implant placement. However, the bone augmentation volume and the surgical complexity could be reduced using autotransplantation.

The patient and her family accepted Plan B. She was treated to a pleasing result in 35 months without TADs or a dental implant (*Figs. 5-7*). The cephalometric and panoramic radiographs document the dentofacial patterns before and after the treatment (*Figs. 8 and 9*). The superimposed cephalometric tracings show the dentofacial changes associated with the treatment (*Fig. 10*). Table 2 is a summary of the cephalometric measurements. A comparison of the alternate treatment plans is illustrated in Fig. 11.

Diagnosis and Etiology

Facial:

- Length: *Long tapered face in the frontal plane*
- Protrusion: *The facial convexity is relatively straight (3° G-Sn-Pg'), which was within the normal limits (WNL) despite mild retrusion of the maxilla (Table 2)*
- Symmetry: *The maxillary dental midline is shifted to the left 1mm, and the chin point is deviated 2mm to the right*
- Smile Line: *The incisal exposure is WNL, but the smile arc was not consistent with the lower lip*

Fig. 5: Post-treatment facial photographs

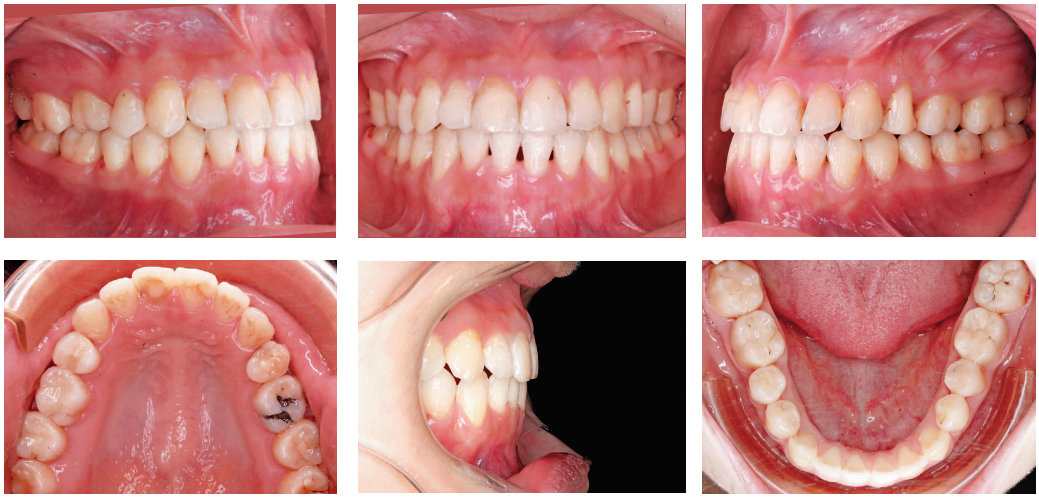


Fig. 6: Post-treatment intraoral photographs

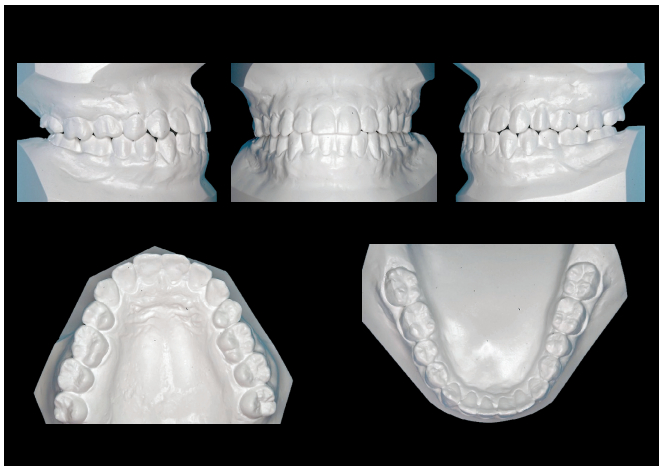


Fig. 7: Post-treatment dental models (casts)

Skeletal:

- Intermaxillary Relationship: *Mild retrusion of the maxilla and mild prognathism of the mandible (SNA 79.5° , SNB 81° , SNA -1.5°) (Table 2)*
- Mandibular Plane: *High mandibular plane (SN-MP 35°, FMA 28°)*
- Vertical Dimension of Occlusion (*VDO*): *Mildly excessive (ANS-Gn is 55% of Na-ANS-Gn dimension), compared to a norm of 53%*
- Symmetry: *Mandible deviation to the right (Fig. 1)*

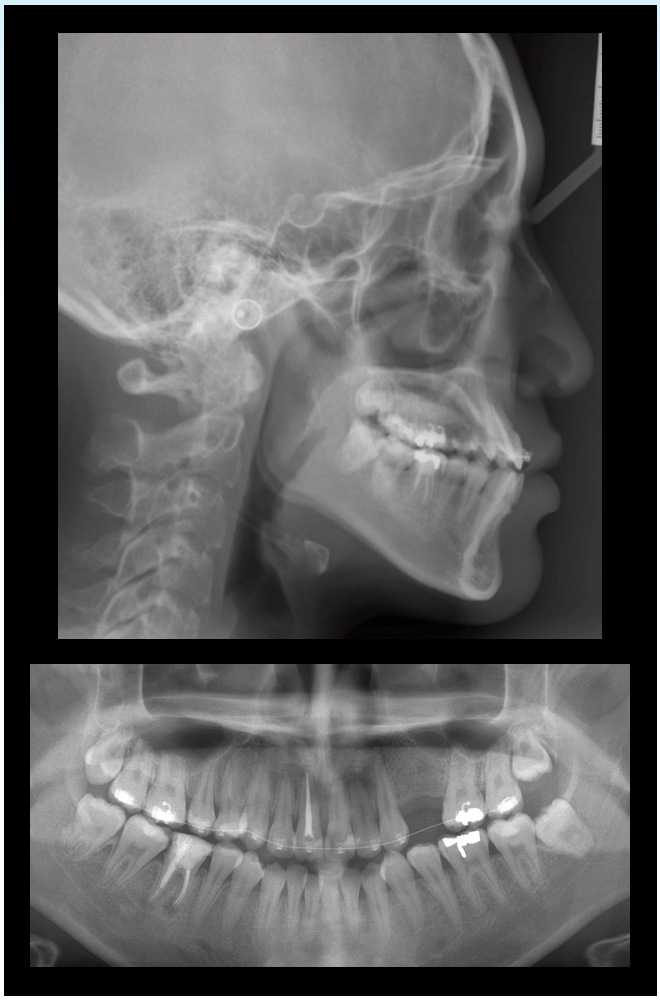


Fig. 8:
Pre-treatment cephalometric (above) and panoramic (below) radiographs.

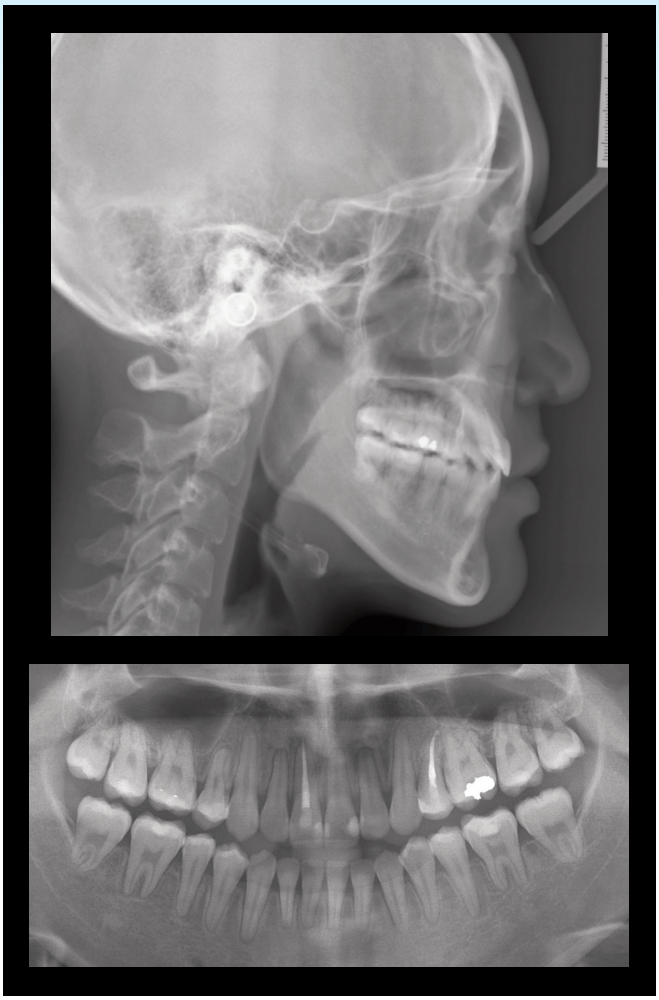


Fig. 9:
Post-treatment cephalometric (above) and panoramic (below) radiographs.

Dental:

- Classification: *Class III molar on the right side, Class I molar on the left side, and bilateral Class III canine relationship (Fig. 3)*
- Overbite: *0mm*
- Overjet: *-1mm (anterior crossbite)*
- Anomalies: *The left maxillary first and second premolars are missing and the left maxillary molars had migrated mesially. The lower right first molar was compromised with failed endodontic treatment.*
- Symmetry: *The maxillary midline had shifted to the left of the facial midline by 1mm, and the lower dental midline was deviated 2mm to the right due to the skeletal problem*
- Crowding: *There was about 5mm of crowding in the lower arch*
- Archforms: *V shaped in the maxilla and ovoid in the mandible*

The American Board of Orthodontics (*ABO*) Discrepancy Index (*DI*) was 20, as documented in the subsequent worksheet.

CEPHALOMETRIC SUMMARY			
SKELETAL ANALYSIS			
	PRE-Tx	POST-Tx	DIFF.
SNA° (82°)	79.5°	79.5°	0°
SNB° (80°)	81°	80°	1°
ANB° (2°)	-1.5°	-0.5°	1°
SN-MP° (32°)	35°	36°	1°
FMA° (25°)	28°	29°	1°
DENTAL ANALYSIS			
U1 To NA mm (4 mm)	7 mm	4.5 mm	2.5 mm
U1 To SN° (104°)	108°	106.5°	1.5°
L1 To NB mm (4 mm)	6 mm	2 mm	4 mm
L1 To MP° (90°)	90°	81°	9°
FACIAL ANALYSIS			
E-LINE UL (-1 mm)	-2 mm	-4 mm	2 mm
E-LINE LL (0 mm)	0 mm	-2.5 mm	2.5 mm
%FH: Na-ANS-Gn (53%)	54%	54.5%	0.5%
Convexity: G-Sn-Pg' (13°)	0°	3°	3°

Table 2: Cephalometric summary

Treatment Objectives

There were two principal treatment objectives: 1. autotransplantation of the UR5 to the UL4 site, 2. extract both lower first molars and protract 2nd and 3rd molars to close the spaces bilaterally and correct the Class III malocculsion.

Maxilla (all three planes):

- A–P: *Maintain*
- Vertical: *Maintain*
- Transverse: *Maintain*

Mandible (all three planes):

- A – P: *Retract*
- Vertical: *Increase*
- Transverse: *Maintain*

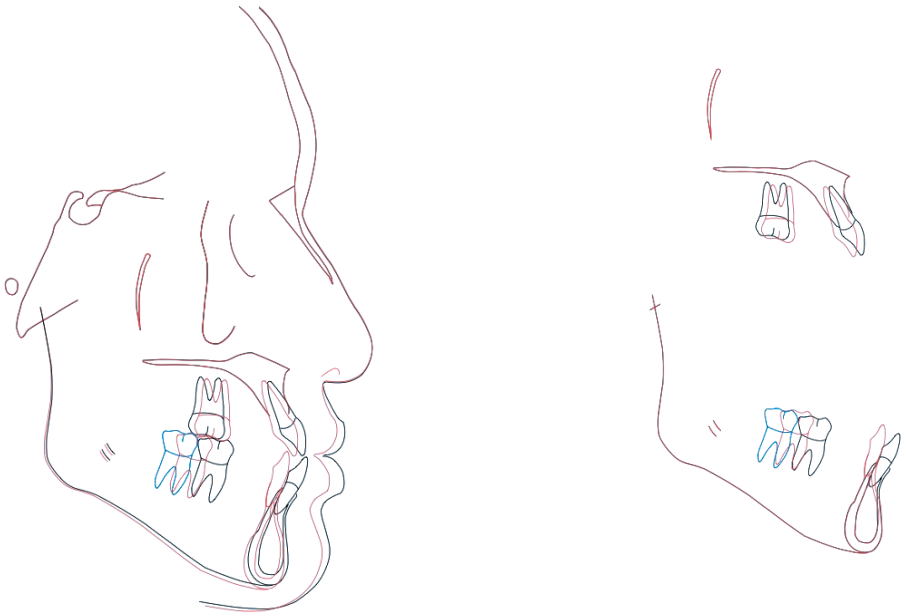


Fig. 10:
Superimpositions of cephalometric tracings show the pre-treatment (black) and post-treatment (red) dentofacial morphology. Mandibular 2nd molars are in blue.

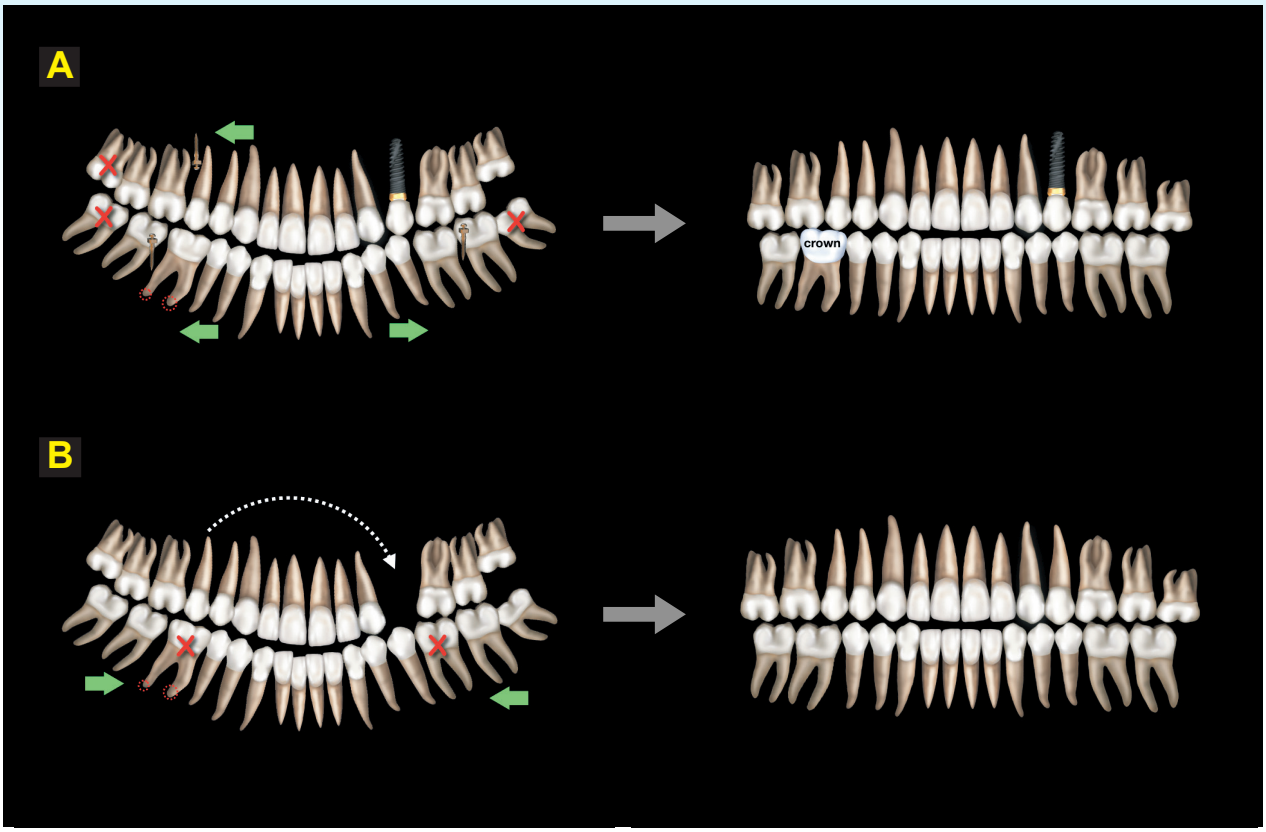


Fig. 11:

*A. **Plan A**: One dental implant is used to restore the UL4, three third molars are extracted, TAD anchorage is used to align the dentitions, and a crown is placed on the compromised lower right first molar.*

*B. **Plan B**: Autotransplantation of the UR5 to replace the missing UL4, extract both lower first molars, and close space to resolve the Class III malocclusion.*

Maxillary Dentition:

- A–P: *Retract*
- Vertical: *Maintain*
- Transverse: *Expand*

Mandibular Dentition:

- A–P: *Retract*
- Vertical: *Maintain*
- Transverse: *Maintain*

Facial Esthetics:

- Convexity: *Increase facial convexity*

Treatment Alternatives

Plan A

First, extract the bilateral mandibular wisdom teeth and the maxillary right wisdom tooth. Second, retract the lower dentition utilizing TAD anchorage bilaterally in both buccal shelves. Third, correct the upper midline by applying one TAD in the right maxillary infrazygomatic crest. Fourth, perform endodontic re-treatment and place a dental crown on the right mandibular first molar. Fifth, leave the space of the missing left maxillary first premolar for future dental implantation. It was clear to the family

that many aspects of Plan A were challenging: TAD anchorage, a dental implant in an inadequate left upper edentulous space, requirements for bone/soft tissue augmentation, and low probability for successful restoration of the compromised lower right first molar. In addition, three healthy teeth would be lost.

Plan B

Bilateral extraction of mandibular first molars, space closure, and autotransplantation of the right maxillary second premolar to left premolar edentulous space. This conservative approach corrects the Class III crowded malocclusion, and is more predictable for restoration of the atrophic edentulous ridge. Plan B was the most cost-effective and conservative approach for a near ideal result.

Appliances and Treatment Progress

0.022-in slot Damon Q® passive self ligating (*PSL*) brackets (*Ormco, Glendale, CA*) with standard torque were bonded on all teeth in the lower arch except for the incisors (*Fig. 12*). The lower right central and left lateral incisors were bonded with low torque brackets positioned upside down in order to reverse root torque from -11 degrees to +11 degrees. The right mandibular lateral incisor (*LR2*) and the left mandibular central incisor (*LL1*) were not bonded at the beginning of the treatment to simplify alignment with the initial 0.013-in CuNiTi archwire.

In the first month of treatment, inter-proximal reduction (*IPR*) was performed on the mesial of the right mandibular first molar (*Fig. 13*) to help initiate alignment. In the fourth month of treatment, all the

Fig. 13:
One month (1M) later, IPR was performed on the mesial side of LR6 to create space to align the LR5.

Fig. 12:
At the beginning of the treatment, the lower dentition was bonded with standard torque Damon Q® brackets except for the lower incisors. LR1 and LL2 were bonded with low torque brackets positioned upside down. LR2 and LL1 were not bonded in the beginning to prevent round tripping.

teeth in the upper arch were bonded with standard torque brackets (*Fig. 14*). However, a Damon Q® high torque (*+11 degrees*) bracket was used instead on the blocked-out upper right canine to improve root movement. An open coil spring was applied to create more space for the right maxillary second premolar. Moreover, a ligature tie holding this tooth firmly to the archwire was made to exert a lateral expansion movement. Inter-maxillary early light short elastics (*ELSE*) (*Quail 3/16, 2-oz*) were applied from the lower first premolars to the upper first molars bilaterally. Following lower first molar extraction, Class I elastics (*Quail 3/16, 2-oz*) were applied bilaterally from the lower first premolars to the lower second molars to close the lower first molar extraction spaces (*Fig. 14*).

In the seventh month of treatment, alignment was improved with a rectangular wire (*Fig. 15*). Brackets were bonded on the LR2 and LL1 when space was adequate. Mandibular second premolars and second molars were bonded with lingual buttons bilaterally. Utilizing buccal and lingual power chains, the space was closed efficiently.

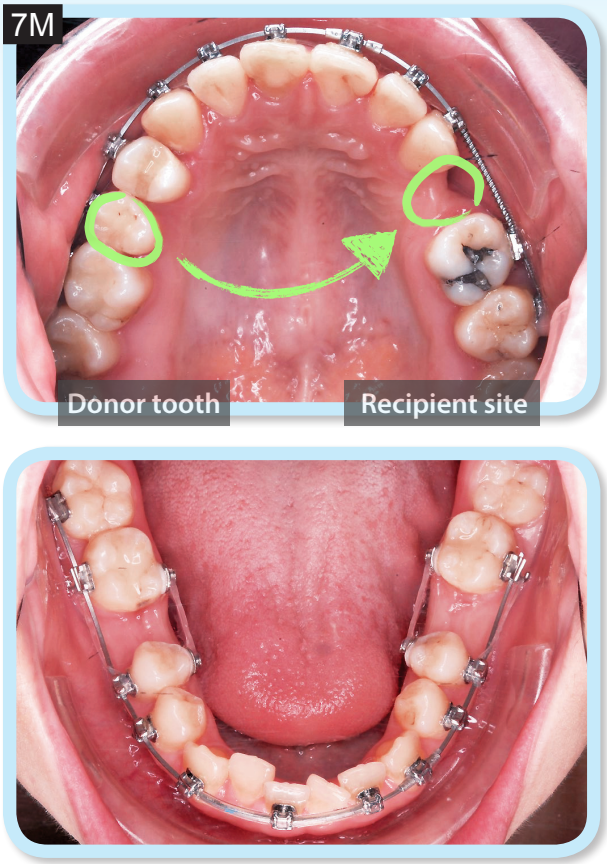


Fig. 15:
***Upper**: After seven months of treatment (7M), the green arrow shows the donor tooth (UR5) was autotransplanted to the recipient site (UL4).*
***Lower**: Power chains were used on the buccal and lingual surfaces to close first molar spaces.*

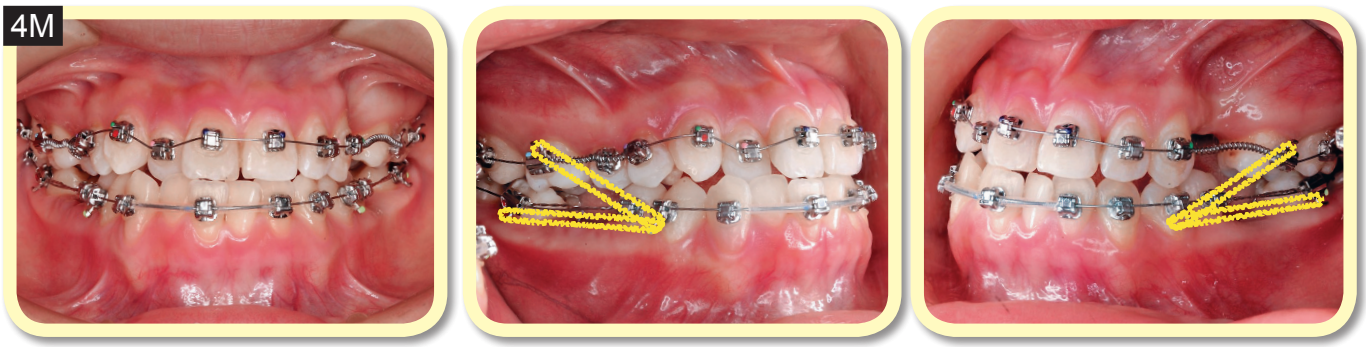


Fig. 14:
After four months of treatment (4M), the upper dentition was bonded with standard torque brackets, except for UR3, which received a high torque bracket. Quail elastics were used from UR6-LR4, LR7-LR4, UL6-LL4, and LL7-LL4.

By the ninth month of treatment, the recipient site was orthodontically prepared (*Fig. 16*). A periodontist conducted the surgery in which the right maxillary second premolar was extracted and transplanted to its contralateral first premolar position. Before the surgery, a CBCT image was obtained. An analog of the donor tooth UR5 was made with 3D printing and used to help prepare the recipient site (*Fig. 17*). This procedure minimizes the duration of the extra-oral time for the donor tooth to help preserve PDL cells attached to the root surface.[2] Moreover, the orthodontic forces applied to the periodontally healthy tooth increased its mobility so that extraction trauma was reduced and intact PDL tissue was maintained.[3] The increased tooth mobility with orthodontics is associated with a gradual widening of the periodontal space, PDL bone resorption, and increased periodontal vascularity.[3] Both procedures increase autotransplantation success. The atrophic recipient site was restored with a freeze-dried bone allograft (*FDBA*), enamel matrix derivatives (*Emdogain®; EMD*),[4] and a connective tissue graft to improve osseous structural quality (*Fig. 18*).

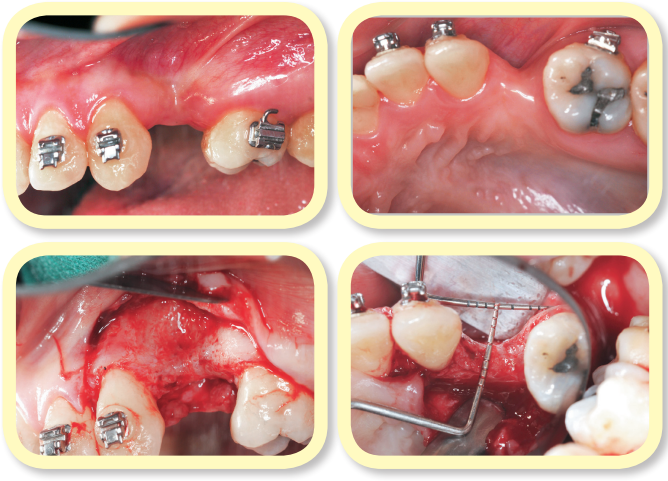


Fig. 16:
An alveolar ridge deficiency was apparent after flap reflection of the recipient site.

Once space for crowded out incisors was adequate (*Fig. 19*), LR2 and the LL1 were bonded with low torque Damon Q® brackets also positioned upside down. The archwire was switched from 0.014x0.025-in CuNiTi back to 0.013-in CuNiTi rounded wire for leveling and alignment.

With progressive space closure of the mandibular second and third molars, a bowing effect (*deep curve of Spee and posterior open bite*) was observed in the 12th month of treatment. As shown in Fig. 20, intermaxillary elastics (*Fox 1/4 inch 3.5-oz*) were on the buccal and lingual surfaces of teeth in both buccal segments to close the posterior openbite and assist in the intermaxillary correction.

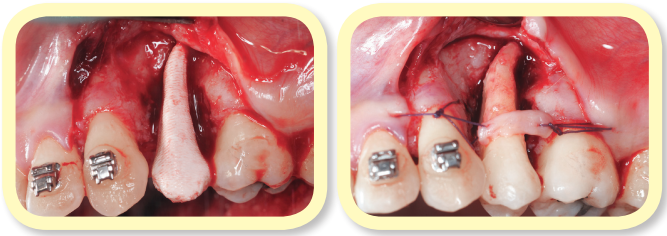


Fig. 17:
A 3D-printed replica of the UR5 was used to prepare recipient site (left). Donor tooth UR5 was transplanted and immobilized by connective tissue graft (right).

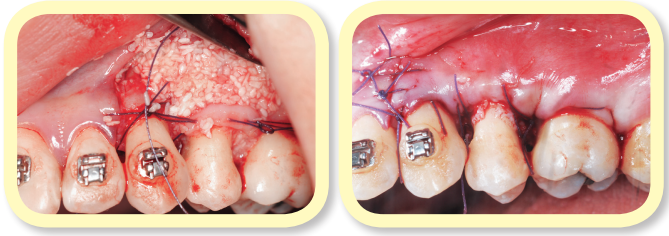


Fig. 18:
The socket around the recipient site was grafted with allograft material (FDBA) and enamel matrix derivative (EMD) after tooth transplantation (left). The closure with sutures is shown (right).

Fig. 19:
Left: After nine months (9M) of treatment the post-operative view of the upper arch is shown.
Center: Spaces are prepared in the lower arch for the LR2 and LL1 were prepared .
Right: The front view is shown after the low torque Damon Q® brackets are positioned upside down on the lower incisors.

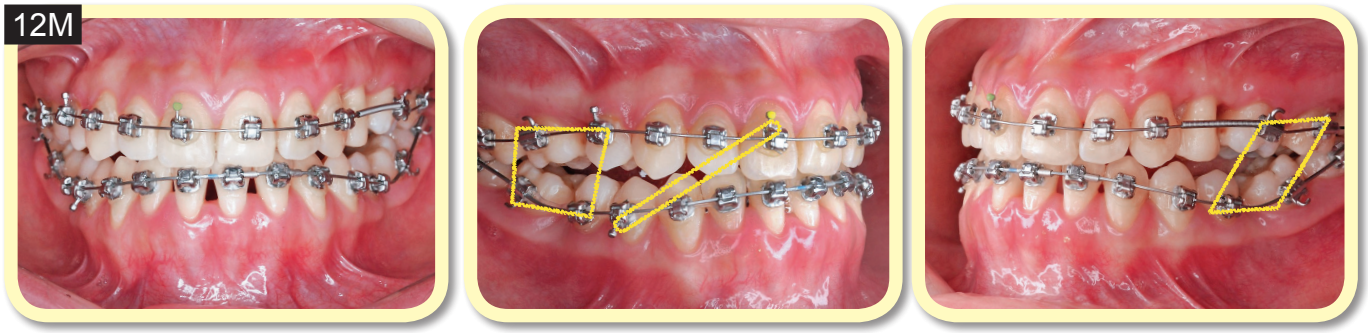


Fig. 20:
After twelve months (12M) of treatment, elastics (Fox 1/4 inch 3.5-oz) were used on the lingual and buccal surfaces to close the posterior openbite and midline. See text for details.

Bracket repositioning was performed repeatedly throughout the treatment as indicated by the sequential panoramic radiographs (*Fig. 21*). Archwires were adjusted to detail the occlusion. Twenty-three months were needed to close the spaces and another 12 months were required for final detailing. The overall treatment time is 35 months (*Fig. 22*).

Results Achieved

All the original objectives of the treatment have been achieved (*Figs. 5-7*). The maxillary and mandibular arches were well aligned in a Class I canine relationship. The overbite and the overjet are optimal (*Fig. 9*), and the lower extraction sites were completely closed by retracting the anterior segment and protracting the lower molars (*Fig. 10*).

Maxilla (all three planes):

- A – P: *Maintained*
- Vertical: *Maintained*
- Transverse: *Maintained*

Mandible (all three planes):

- A – P: *Reduced*
- Vertical: *Increased*
- Transverse: *Maintained*

Fig. 21:
Bracket repositioning was performed as indicated by panoramic radiographs taken form 10-26mo (10M, 20M, 26M).

Fig. 22: After twenty-three months (23M) of treatment, spaces are nearly closed and the arches are well aligned.

Maxillary Dentition

- A – P: *Retracted*
- Vertical: *Maintained*
- Transverse: *Expanded*

Mandibular Dentition

- A – P: *Incisors retracted and molars protracted*
- Vertical: *Maintained*
- Transverse: *Maintained*

Facial Esthetics:

- Increased convexity and reduction of lip protrusion

Retention

The upper and lower arch corrections were retained with Hawley retainers full time for the first six months and nights only thereafter. Guidance for home hygiene as well as maintenance of the retainers was provided.

Final Evaluation of Treatment

Overall, the patient was pleased with the substantial improvement in facial esthetics, dental alignment, and functional occlusion. The right maxillary second premolar was successfully autotransplanted to the position of the contralateral first premolar. Moreover, the spaces in the posterior mandible were closed by protracting the molars. No implants, TADs nor extensive restorative dentistry was required.

The ABO Cast-Radiograph Evaluation (*CRE*) score was 16 points. There were minor discrepancies in two categories: marginal ridges (*3 points*) and alignment rotation (*4 points*). The right mandibular third molar was tipped lingually which resulted in marginal ridge discrepancies and excessive buccolingual inclination of the posterior segments (*Fig. 7*).

Discussion

Orthodontic protraction of mandibular molars to replace missing first molars is challenging because of the dense mandibular cortical bone in the posterior segment. Pre-treatment assessment should include periodontal health, alveolar bone mass, root morphology of the lower molars, and the zone of attached gingiva. Positive factors are adequate bone width and height. A knife-edge atrophic ridge may result in root resorption. Third molars with two defined roots are superior to one with a single conical root. Although space reopening is a concern, neither space recurrence nor increased pocket is reported in follow-up evaluation.[5,6]

Protracting molars with only buccal force can lead to mesial rotation and increased curve of Spee (*posterior openbite*).[7] Crossbite may occur if the maxillary arch is narrow. Intermaxillary cross elastics and power chains on both the buccal and lingual sides of the lower buccal segments may be required. Molar tipping to the mesial is preventable by taking the following few precautions. Longer buccal hooks can help the force pass through the plane of the center of resistance for a molar. Next, a molar uprighting spring can introduce an uprighting force to offset the tendency to tip mesially. In addition, rebonding the molar tube down on the mesial surface can improve the root mesial moment supplied by the archwire. Finally, a tip back bend can also help.[8] Although molar protraction is challenging, the lower molars were presently protracted 6mm. Baik et al.[5] have shown that these methods are effective for closing up to 12mm of space.

Tooth extraction results in alveolar bone resorption,[9] so lower first molar extractions were delayed until immediately prior to initiating space closure. The post-operative regional acceleratory phenomenon (*RAP*) in and around the extraction site helps accelerate the process of space closure.

Tooth autotransplantation is defined as extracting a healthy tooth and transplanting it into an extraction socket or edentulous ridge, so it replaces a tooth which either has been lost or has a poor prognosis.[10] The survival rate for tooth autotransplantation ranges from 81.4% to 90%.[11] According to Tsukiboshi et al.,[12] the survival rate may increase up to 100% for immediate transplantation into a properly prepared fresh extraction site. However, when the recipient site is an edentulous ridge, the survival rate can drop

to 75% because it is necessary to artificially prepare a socket. All things considered, a meta-analysis published in 2014 reported the survival rate was 98% after one year and as high as 90.5% after five years.[13]

In order to increase the success rate for tooth autotransplantation, it is critical to preserve a healthy periodontal ligament (*PDL*) on the donor tooth.[14] This is best accomplished with atraumatic surgery and a short extra-oral period between extraction and implantation. Orthodontic movement of the donor tooth prior to extraction facilitates its removal so there is less damage to the PDL. Before the surgery, a CBCT image is useful to print a 3D analog replica which can be used to shorten the extra-oral duration by preparing the site. FDBA and Emdogain® were used to enhance the repair and regeneration process for PDL cells on the surface of the root.[15]

Autotransplantation and implant-supported prostheses are effective solutions for missing teeth. The pros and cons for each approach are presented in Table 3. The biggest advantage of autotransplantation is the use of a natural tooth with a PDL that promotes periodontal bone formation. Unfortunately, this approach is not often used in clinical practice because of unfamiliarity with the surgical procedures and associated dental physiology. In contrast to dental implants, autotransplantation is less expensive and requires less time. When indicated, autotransplantation is a viable option compared to an implant-supported prosthesis.

	Autotransplanted tooth	Dental implant
Source	Limited	Commercial
Periodontal ligment	Yes	No
Osseointegration	No	Yes
Inducing bone formation	Yes	No
Moved by orthodontic force	Yes	No
Treatment time	Shorter	Longer
Restoration procedure	Straightforward	Delicate
Caries incidence	Yes	No
Periodontal/peri-implant infection	Yes	Yes
Response to infection treatment	Predictable	Unpredictable
Maintenance cost	Low	High
Moved with craniofacial growth	Yes	No

Table 3: Comparison of an autotransplanted tooth and dental implant.

Conclusions

Autotransplantation and substitution of lower second and third molars for first molars were a cost-effective solution for a complex Class III malocclusion with a compromised first molar and an atrophic edentulous space. The success rate for an autotransplant can be improved by the application of CBCT and 3D printing technology. This conservative approach preserved healthy teeth and resulted in an optimal outcome.

Acknowledgment

The authors wish to thank the following important contributors: Dr. Tien-Chun Kuo for the root canal treatment of the transplanted tooth; Dr. Jeng-Feng Hwang for composite restoration and temporary crowns of the autotransplanted teeth; Dr. Rungsi Thavarungkul for the templates that clearly demonstrate the treatment plan and Mr. Paul Head for proofreading.

References

1. Moraschini V, Poubel LA, Ferreira VF, Barboza Edos S. Evaluation of survival and success rates of dental implants reported in longitudinal studies with a follow-up period of at least 10 years: a systematic review. Int J Oral Maxillofac Surg 2015;44(3):377-88.
2. Proye MP, Polson AM. Repair in different zones of the periodontium after tooth reimplantation. J Periodontol 1982;53(6):379-89.
3. Miron RJ, Sculean A, Cochran DL, Froum S, Zucchelli G, Nemcovsky C, Donos N, Lyngstadaas SP, Deschner J, Dard M, Stavropoulos A, Zhang Y, Trombelli L, Kasaj A, Shirakata Y, Cortellini P, Tonetti M, Rasperini G, Jepsen S, Bosshardt DD. Twenty years of enamel matrix derivative: the past, the present and the future. J Clin Periodontol 2016;43(8):668-83.
4. Prato GP, Zuccati G, Clauser C. Commentary: a translational medicine approach to tooth transplantation. J Periodontol 2017;88(6):519-25.
5. Baik UB, Chun YS, Jung MH, Sugawara J. Protraction of mandibular second and third molars into missing first molar spaces for a patient with an anterior open bite and anterior spacing. Am J Orthod Dentofacial Orthop 2012;141(6):783-95.
6. Nagaraj K, Upadhyay M, Yadav S. Titanium screw anchorage for protraction of mandibular second molars into first molar extraction sites. Am J Orthod Dentofacial Orthop 2008;134(4):583-91.
7. Baik UB, Park JH. Molar protraction: orthodontic substitution of missing posterior teeth. North Charleston, SC: CreateSpace; 2013. p. 96-103.
8. Kyung SH, Choi JH, Park YC. Miniscrew anchorage used to protract lower second molars into first molar extraction sites. J Clin Orthod 2003;37(10):575-9.
9. Ostler MS, Kokich VG. Alveolar ridge changes in patients congenitally missing mandibular second premolars. J Prosthet Dent 1994;71(2):144-9.
10. Park JH, Tai K, Hayashi D. Tooth autotransplantation as a treatment option: a review. J Clin Pediatr Dent 2010;35(2):129-35.
11. Mejàre B, Wannfors K, Jansson L. A prospective study on transplantation of third molars with complete root formation. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2004;97(2):231-8.
12. Tsukiboshi M. Autotransplantation of teeth: requirements for predictable success. Dent Traumatol 2002;18(4):157-80.
13. Chung WC, Tu YK, Lin YH, Lu HK. Outcomes of autotransplanted teeth with complete root formation: a systematic review and meta-analysis. J Clin Periodontol 2014;41(4):412-23.
14. Andreasen JO. Periodontal healing after replantation and autotransplantation of incisors in monkeys. Int J Oral Surg 1981;10(1):54-61.
15. Sculean A, Schwarz F, Becker J, Brecx M. The application of an enamel matrix protein derivative (Emdogain) in regenerative periodontal therapy: a review. Med Princ Pract 2007;16(3):167-80.

Discrepancy Index Worksheet

TOTAL D.I. SCORE 20

OVERJET

0 mm. (edge-to-edge)	=	1 pt.
1 – 3 mm.	=	0 pts.
3.1 – 5 mm.	=	2 pts.
5.1 – 7 mm.	=	3 pts.
7.1 – 9 mm.	=	4 pts.
> 9 mm.	=	5 pts.

Negative OJ (x-bite) 1 pt. per mm. per tooth =

Total = 8

OVERBITE

0 – 3 mm.	=	0 pts.
3.1 – 5 mm.	=	2 pts.
5.1 – 7 mm.	=	3 pts.
Impinging (100%)	=	5 pts.

Total = 0

ANTERIOR OPEN BITE

0 mm. (edge-to-edge), 1 pt. per tooth
then 1 pt. per additional full mm. per tooth

Total = 2

LATERAL OPEN BITE

2 pts. per mm. per tooth

Total = 0

CROWDING (only one arch)

1 – 3 mm.	=	1 pt.
3.1 – 5 mm.	=	2 pts.
5.1 – 7 mm.	=	4 pts.
> 7 mm.	=	7 pts.

Total = 2

OCCLUSION

Class I to end on	=	0 pts.
End on Class II or III	=	2 pts. per side 2 pts.
Full Class II or III	=	4 pts. per side ____ pts.
Beyond Class II or III	=	1 pt. per mm. additional ____ pts.

Total = 2

LINGUAL POSTERIOR X-BITE

1 pt. per tooth Total = 0

BUCCAL POSTERIOR X-BITE

2 pts. per tooth Total = 0

CEPHALOMETRICS (See Instructions)

ANB ≥ 6° or ≤ -2° -1.5° = 4 pts.

Each degree < -2° _____ x 1 pt. = _____

Each degree > 6° _____ x 1 pt. = _____

SN-MP 35°

≥ 38° = 2 pts.

Each degree > 38° _____ x 2 pts. = _____

≤ 26° = 1 pt.

Each degree < 26° _____ x 1 pt. = _____

1 to MP ≥ 99° 90° = 1 pt.

Each degree > 99° _____ x 1 pt. = _____

Total = 0

OTHER (See Instructions)

Supernumerary teeth	_____	x 1 pt. =	_____
Ankylosis of perm. teeth	_____	x 2 pts. =	_____
Anomalous morphology	_____	x 2 pts. =	_____
Impaction (except 3rd molars)	_____	x 2 pts. =	_____
Midline discrepancy (≥3mm)		@ 2 pts. =	_____
Missing teeth (except 3rd molars)	2	x 1 pts. =	2
Missing teeth, congenital	_____	x 2 pts. =	_____
Spacing (4 or more, per arch)	_____	x 2 pts. =	_____
Spacing (Mx cent. diastema ≥ 2mm)		@ 2 pts. =	_____
Tooth transposition	_____	x 2 pts. =	_____
Skeletal asymmetry (nonsurgical tx)		@ 3 pts. =	_____
Addl. treatment complexities	2	x 2 pts. =	4

Identify: Alveolar ridge atrophy
Need autotransplantation

Total = 6

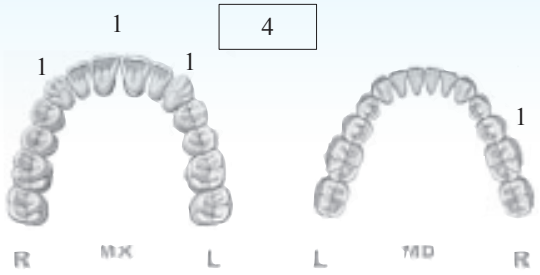
Cast-Radiograph Evaluation

Case # **Patient**

Total Score: 16

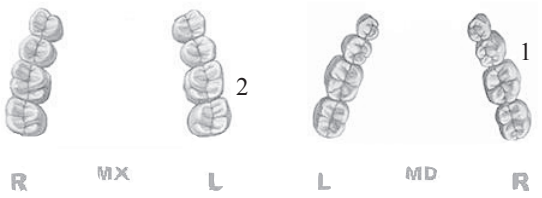
Alignment/Rotations

4



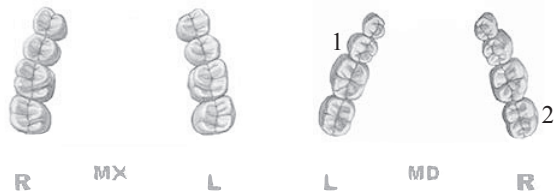
Marginal Ridges

3



Buccolingual Inclination

3

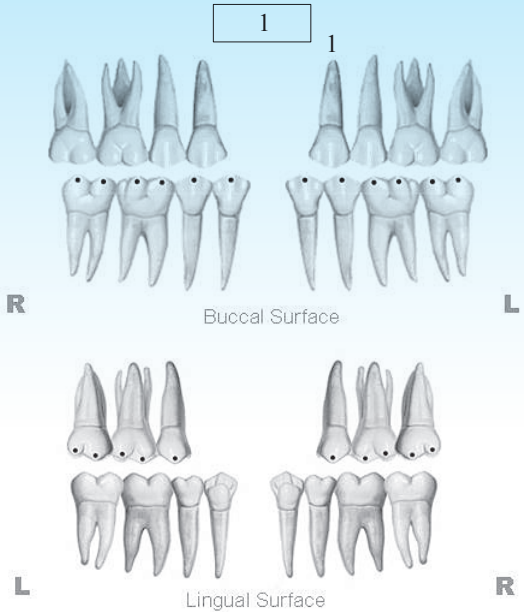


Overjet

2

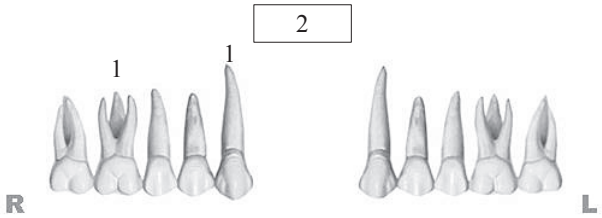
Occlusal Contacts

1



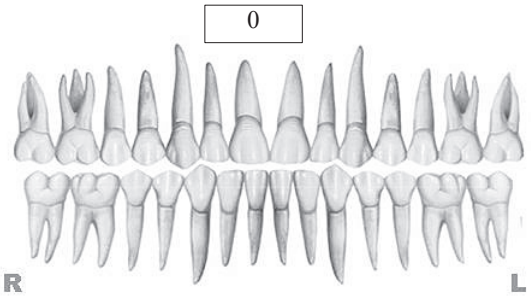
Occlusal Relationships

2



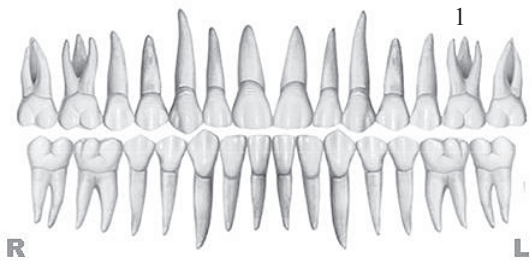
Interproximal Contacts

0



Root Angulation

1



INSTRUCTIONS: Place score beside each deficient tooth and enter total score for each parameter in the white box. Mark extracted teeth with "X". Second molars should be in occlusion.