The T-Control Philosophy and Prescription for Passive Self-Ligating Brackets

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The low friction of passive self-ligating brackets, which can approach zero with some wire thicknesses, enables initial tooth movement to be as physiological as possible.[1,2] Lower friction can lead to a loss of torque control,[1,3-5] however, thus increasing the difficulty of correcting rotation and torque during the finishing phase of treatment.[4,5] One reason for these issues is that the narrower widths and larger slots of self-ligating brackets permit greater play, especially in passive versions.[1,5-8] With an .022" slot, the play between bracket and slot ranges from 7.8-23.9° for an .019" × .025" archwire to 2.9-8.4° for an .021" × .025" archwire.[5,8]


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To enhance torque expression with passive self-ligating brackets, we have developed a bidimensional prescription with variable slots and customized torque and angulation values for the anterior, buccal, and posterior archwire segments. The T-Control philosophy was developed concurrently to improve the biomechanical performance of passive self-ligating appliances, allowing individualized treatment planning for various malocclusions. This treatment philosophy includes seven steps:

1. Diagnosis
2. Modified bracket prescription
3. Stops
4. Bite-raising devices
5. Elastics
6. Wire sequence
7. Skeletal anchorage

The T-Control philosophy is illustrated in the following Class III case.

Fig. 1 15-year-old female patient with skeletal Class III malocclusion, facial asymmetry, and inclined occlusal plane before treatment (continued on next page).

Diagnosis

A 15-year-old female presented with a skeletal Class III malocclusion and a concave profile (Fig. 1). She had undergone previous treatment with a functional orthopedic appliance. Clinical evaluation found facial asymmetry, a passive lip seal, and an asymmetrical smile; the lower midline was deviated to the left. The patient had a bilateral Class III molar relationship with an anterior and posterior open bite, anterior and posterior maximum intercuspation, and an altered occlusal plane.

A panoramic tomographic evaluation with the teeth in occlusion revealed unerupted third molars. Cephalometric analysis confirmed the facial asymmetry and lower midline deviation, as well as the steep posterior occlusal plane characteristic of lateral and anterior open bite (Table 1). Significant maxillomandibular prognathism and an asymmetrical occlusal plane in the vertical direction were also apparent.

Treatment objectives included correction of the Class III malocclusion, dentoalveolar remodeling with leveling and alignment, correction of the midline deviation and bilateral open bite, and achievement of an esthetic functional plane by means of inclination correction and mandibular molar intrusion. Treatment would be concluded

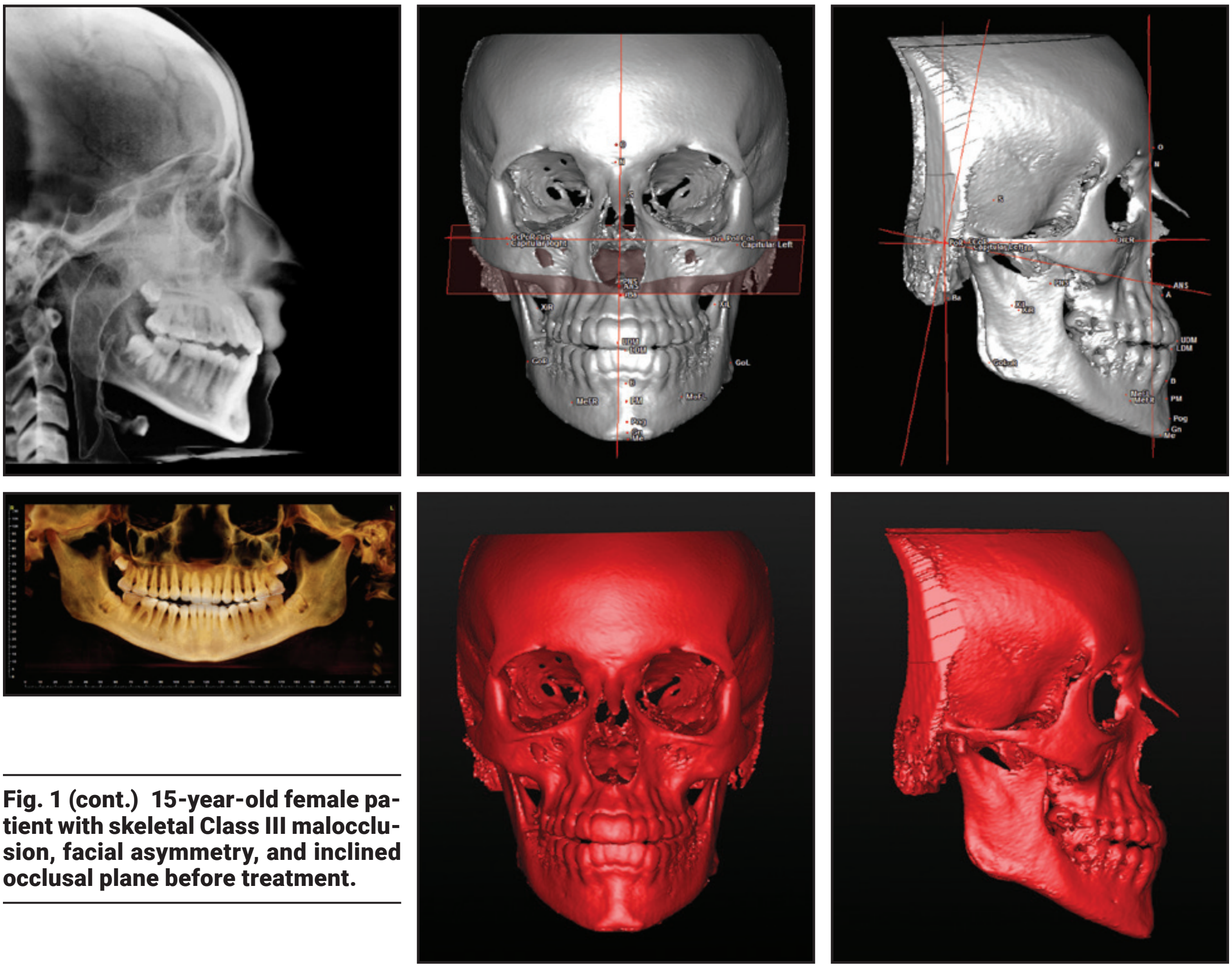

Fig. 1 (cont.) 15-year-old female patient with skeletal Class III malocclusion, facial asymmetry, and inclined occlusal plane before treatment.

TABLE 1
CEPHALOMETRIC ANALYSIS

	Pretreatment	Post-Treatment	Change
Camper plane-Upper left first premolar	26.00mm	24.80mm	−1.20mm
Camper plane-Upper right first premolar	24.00mm	24.04mm	+0.04mm
A-N perp	4.36mm	3.53mm	−0.83mm
Pog-N perp	7.02mm	7.06mm	+0.04mm
Midsagittal plane-Lower left canine	16.75mm	13.00mm	−3.75mm
Midsagittal plane-Lower right canine	11.74mm	12.30mm	+0.56mm
SNA	82.64°	81.13°	−1.51°
SNB	81.80°	80.59°	−1.21°
Midsagittal plane-Gn	4.03mm left	1.00mm left	−3.03mm

with intercuspation and adjustments to occlusal guidance for optimal function and esthetics.

Therapeutic options included surgical-orthodontic treatment, nonsurgical compensatory orthodontics with mandibular first-premolar extractions, or a less conventional approach involving distalization of the mandibular teeth with anchorage from miniplates or miniscrews. We recommended compensatory orthodontic treatment utilizing the T-Control philosophy with passive self-ligating brackets.

Extractions are a major issue when using passive self-ligating appliances; the decision should consider not only the amount of crowding, but also the facial profile, nasolabial angle, muscular function, buccal corridors, and lip seal. In the case presented here, only the maxillary and mandibular third molars were extracted, because the patient had a skeletal Class III malocclusion associated with maxillary vertical elongation, a short anteroposterior dimension, and posterior crowding.[9-11]

Modified Bracket Prescription

The T-Control prescription is an individualized modification of the basic MBT* prescription (Fig. 2).[12-16] We use the new Tellus EX** passive self-ligating metal bracket. In the T-Control prescription, the anterior brackets have .018" × .028" slots; brackets and tubes from the canines to the molars have .022" × .028" slots, with specific torque and angulation for each archwire segment.

In our Class III case, upper Tellus EX brackets with .5mm of torque added to the central and lateral incisors were bonded at the first appointment, and low-force .014" copper nickel titanium archwires were inserted (Fig. 3). Four weeks later, at the second appointment, the mandibular arch was bonded with .5mm of torque subtracted for the central and lateral incisors (Fig. 4).

Stops

Stops can be metal accessories, such as round or rectangular tubes, or can be fabricated from flowable or Top Comfort*** composite resin. Stops are used both to guide orthodontic movements and to improve patient comfort after archwire placement, since passive self-ligating appliances have extremely low friction.[2,17] For the present case, metal stops were placed on the mesial aspects of the upper right and left second molars to produce the upper-arch expansion known as the “omega effect.” The archwire initially by-

	U7	U6	U4,5	U3	U2	U1	Upper Arch
A	2.0	4.5	5.5	6.0	5.5	6.0	+1.0 mm
B	2.0	4.0	5.0	5.5	(5.0)	(5.5)	+0.5 mm
→	(2.0)	(3.5)	(4.5)	(5.0)	4.5	5.0	Average
D	2.0	3.0	4.0	4.5	4.0	4.5	-0.5 mm
E	2.0	2.5	3.5	4.0	3.5	4.0	-1.0 mm
A	3.5	4.0	5.0	5.5	5.0	5.0	+1.0 mm
→	(3.0)	(3.5)	(4.5)	(5.0)	4.5	4.5	+0.5 mm
C	2.5	3.0	4.0	4.5	(4.0)	(4.0)	Average
D	2.0	2.5	3.5	4.0	3.5	3.5	-0.5 mm
E	2.0	2.0	3.0	3.5	3.0	3.0	-1.0 mm
	U7	U6	U4,5	U3	U2	U1	Lower Arch

B

	UR5	UR4	UR3	UR2	UR1	UL1	UL2	UL3	UL4	UL5
SLOT	0.022"	0.022"	0.022"	0.018"	0.018"	0.018"	0.018"	0.022"	0.022"	0.022"
Width	2,58mm	2,58mm	1,98mm	2,47mm	2,3mm	2,3mm	2,47mm	1,98mm	2,58mm	2,58mm
Torque	-7°	-7°	+7°	+10°	+17°	+17°	+10°	+7°	-7°	-7°
Angle	0°	0°	+8°	+8°	+4°	+4°	+8°	+8°	0°	0°
In/Out	0,8mm	0,8mm	0,8mm	1,09mm	0,9mm	0,9mm	1,09mm	0,8mm	0,8mm	0,8mm
	5	4	3	2	1	1	2	3	4	5

	LR5	LR4	LR3	LR2	LR1	LL1	LL2	LL3	LL4	LL5
	5	4	3	2	1	1	2	3	4	5
SLOT	0.022"	0.022"	0.022"	0.018"	0.018"	0.018"	0.018"	0.022"	0.022"	0.022"
Width	2,27mm	2,06mm	2,05mm	2,27mm	2,27mm	2,27mm	2,27mm	2,05mm	2,06mm	2,27mm
Torque	-17°	-12°	+7°	-6°	-6°	-6°	-6°	+7°	-12°	-17°
Angle	0°	0°	+3°	0°	0°	0°	0°	+3°	0°	0°
In/Out	0,8mm	0,8mm	0,8mm	1,09mm	1,09mm	1,09mm	1,09mm	0,8mm	0,8mm	0,8mm

C

Fig. 2 A. Maxillary and mandibular incisor torque values based on reference measurements from MBT* prescription. B. Example of "smile protection" prescription with highlighted customization. C. T-Control prescription with slot size, bracket width, angulation, torque, and in-out.

Fig. 3 T-Control passive self-ligating brackets and low-force .014" copper nickel titanium archwires** placed at first appointment.**

passed the 1mm slots of the stops, but the stops were later tightened for incorporation of the archwire. In the lower arch, stops were placed on the distal aspects of the right first premolar and left second premolar during the second appointment. These would help control buccal tipping by serving as Class III elastic attachment points during initial anterior alignment.

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Bite-Raising Devices

Bite-raising devices are made from composite resins, glass ionomers, or other adhesives such as Ortho Bite.*** They assist in repositioning the occlusion in centric relation by unlocking the malocclusion, and they help correct the occlusal plane inclination and control lower tipping. They can be placed at various sites, including the occlusal surfaces of posterior teeth, the lingual surfaces of the maxillary canines and incisors (bite turbos), or the lingual surfaces of the mandibular teeth.[18]

For this case, bite-raising devices made of light-cured composite were affixed to the upper right second molar and upper left first and second molars. The bite was positioned higher on the left (the side of the mandibular deviation).

Elastics

Intermaxillary elastics can be used early in treatment with passive self-ligating appliances to aid and guide tooth movement.[18,19] Lighter elastics should be used with light wires; because of the low friction, tooth movement will still be more efficient than with conventional bracket systems using elastomeric ligatures.[2,3,7] In the present case, beginning at the second appointment, light Class III intermaxillary elastics (5⁄16", 60-80g) were initiated from the upper right first molar to the lower right first premolar and from the upper left first molar to the lower left first premolar, to be worn at least 16 hours per day.

The force and duration of wear should be increased as the archwire thickness increases. We generally begin Class III biomechanics when the .014" × .025" copper nickel titanium archwire** is placed. In this case, we prescribed medium Class III intermaxillary elastics (3⁄16", 150-200g) to be worn full-time (Fig. 5). An open-coil Nitinol* spring was added between the lower right canine and first premolar to counteract the elastic force and enhance lower molar distalization by controlling lower tipping.[20,21] For every 15° of tipping correction, there is an average 10mm gain in arch perimeter.[20,22,23] In addition, the lower third molars were extracted before treatment to prevent any impaction that might impede distal movement.[17,23] Only Class III elastics were worn on the left side.[22,23]

Wire Sequence

Universal-size low-force copper nickel titanium wires are used in this technique.[20] To achieve more physiological transverse remodeling from the beginning of treatment, the upper archform is employed for both arches. The usual sequence is .013" or .014" (depending on the degree of crowding), .016", .014" × .025", and .017" × .025", followed by .017" × .025" stainless steel or TMA† wires and/or .016" × .022" stainless steel or TMA wires for finishing. The finishing archwires are always customized according to the patient's WALA ridge.[20,21]

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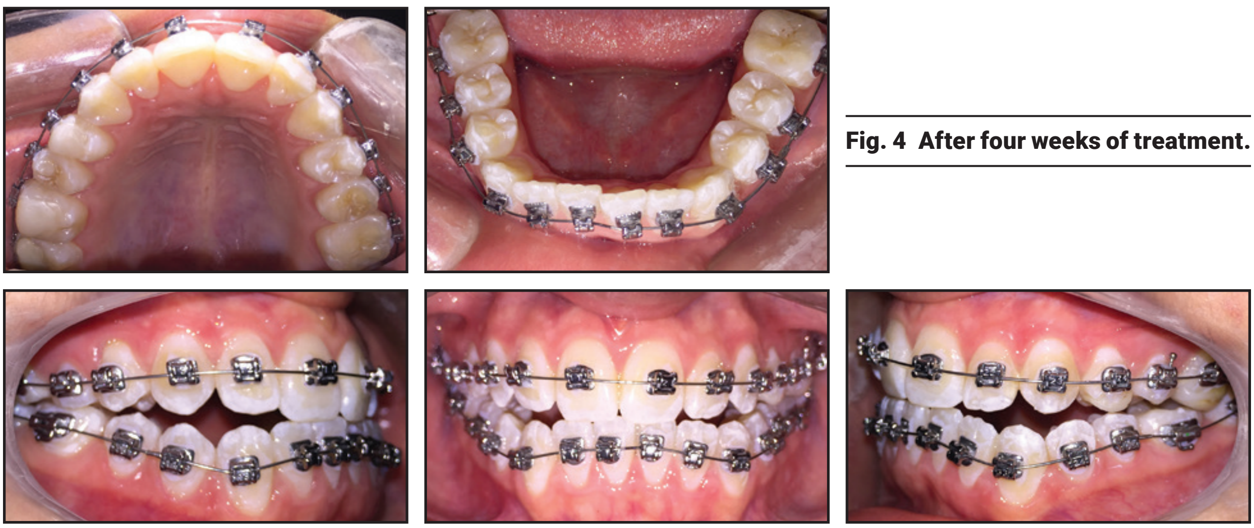


Fig. 4 After four weeks of treatment.

In this case, the bite-raising composite was removed after 24 weeks of treatment, when the .017" × .025" copper nickel titanium archwires were placed.[19,24,25] Eight weeks later, these were replaced with .017" × .025" stainless steel finishing archwires.

Skeletal Anchorage

Intra- or extra-alveolar skeletal anchorage from miniscrews or miniplates may be used as an adjunct to biomechanics if needed.[26,27] Skeletal anchorage was not employed in this particular case.

Treatment Results

After 18 months of treatment, the patient exhibited proper occlusion, mastication, speech, and swallowing functions (Fig. 6). The facial and smile esthetics were considerably improved. Cephalometric analysis (Table 1) and three-dimensional tomographic‡ imaging confirmed correction of the asymmetry and occlusal plane.

Discussion

Although the bidimensional concept has been proposed previously,[28-32] including for use with active self-ligating appliances,[33] our approach appears to be the first for passive self-ligating brackets. Using two slot sizes offers biomechanical advantages including free sliding of posterior teeth during space closure and minimization of frictional retraction forces. This differential mode allows a wider .017" archwire to be used, thus opening .04" of free space in the .022" slots on the canines and premolars. As a result, a free-sliding system is applied during canine retraction, anterior retraction, and posterior protraction, while anterior torque remains constant.[29,32] The T-Control philosophy allows an individualized prescription to be employed during a wire sequence aimed at enhancing torque expression and angulation.[34]

Compensatory orthodontic treatment is a feasible alternative to orthognathic surgery for correcting occlusal relationships in cases with mild midfacial discrepancies.[35] The ideal patient for compensatory treatment is one who has remaining growth and moderate crowding with space for extractions, enabling orthodontic camouflage to be successful.[34,35] Vertical changes to the occlusal plane have the growth-related consequence of modifying the mandibular position, thus improving the stability of compensatory treatment in some cases.[36-38]

A skeletal Class III malocclusion characterized by an anteroposterior discrepancy between

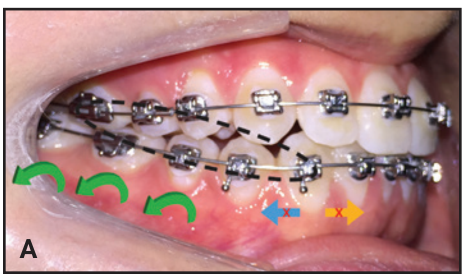
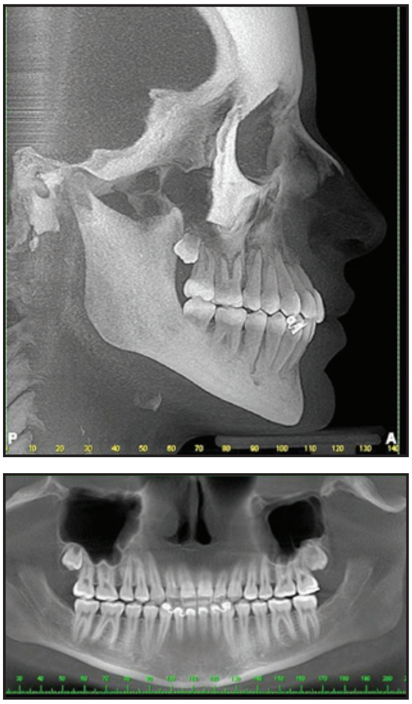


Fig. 5 A. After about 20 weeks of treatment, T-Control Class III biomechanics initiated with medium Class III intermaxillary elastics. Open-coil Nitinol* spring added between lower right canine and first premolar to counteract elastic force and enhance lower molar distalization by controlling lower tipping. B. After 14 months of treatment.

the basal bones due to maxillary deficiency, mandibular excess, or both usually requires orthognathic surgery,[39,40] although skeletal anchorage now offers an alternative for predictable orthodontic treatment.[35] Patients who refuse surgery because of its risks and costs,[40] if they are relatively satisfied with their appearance and do not have TMD requiring surgery, may choose dentoalveolar compensation without complete and ideal correction of the skeletal problems.

Extractions should generally be avoided in any Class III treatment, since this malocclusion is corrected by posterior mandibular rotation and consequently by promoting vertical augmentation. Because the soft tissues do not always follow the hard-tissue morphology, facial evaluation has become an essential component of the diagnosis.[38] If the patient's skeletal issues do not affect the face, compensatory treatment is a possibility. To avoid being misled by a posterior crossbite resulting from pseudoprognathism,[30,40] however, a model surgery should be performed with the dental casts

Fig. 6 A. Patient after 18 months of treatment (continued on next page).



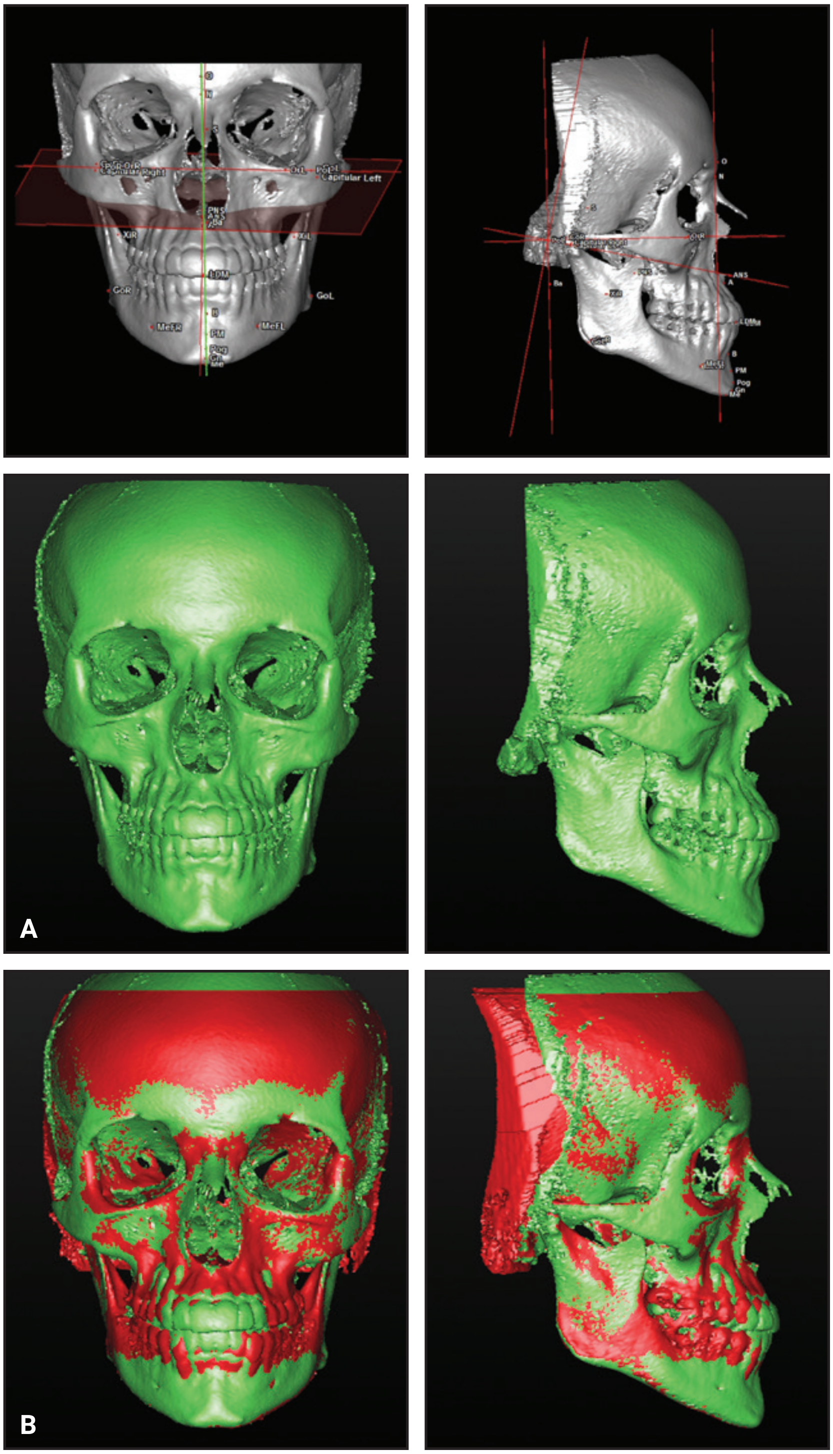


Fig. 6 (cont.) A. Patient after 18 months of treatment. B. Superimposition of pre- and post-treatment tomographic‡ images.

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positioned in a Class I molar relationship on both sides. This provides a more accurate view of maxillary constriction and posterior crossbite. If the casts show a negative overjet or crossbite in this relationship, there is a definite need for maxillary expansion.[38,41]

Patient compliance is the key to treatment using intermaxillary elastics. In the case reported here, the patient was informed of the benefits of wearing Class III elastics, and her excellent compliance provided a significant contribution to treatment success.[21,34,38,41]

REFERENCES

1. Dalastra, M.; Eriksen, H.; Bergamini, C.; and Mensen, B.: Actual versus theoretical torsional play in conventional and self-ligation bracket systems, J. Orthod. 42:103-113, 2015.
2. Ehsani, S.; Mandich, M.A.; El-Bialy, T.H.; and Flores-Mir, C.: Frictional resistance in self-ligating orthodontic brackets and conventionally ligated brackets: A systematic review, Angle Orthod. 79:592-601, 2009.
3. Al-Thomali, Y.; Mohamed, R.N.; and Basha, S.: Torque expression in self-ligating orthodontic brackets and conventionally ligated brackets: A systematic review, J. Clin. Exp. Dent. 9:123-128, 2017.
4. Sathler, R.; Siva, R.G.; Janson, G.; Branco, N.C.C.; and Zandam, M.: Demystifying the self-ligating brackets, Dent. Press J. Orthod. 16:50e1-e8, 2011.
5. Melenka, G.W.; Nobes, D.S.; Carey, J.P.; and Major, P.W.: Three-dimensional deformation comparison of self-ligating brackets, Am. J. Orthod. 143:645-657, 2013.
6. Damon, D.H.: The Damon low-friction bracket: A biologically compatible straightwire system, J. Clin. Orthod. 32:670-680, 1998.
7. Pacheco, M.R.; Oliveira, D.D.; Smith Neto, P.; and Jansen, W.C.: Evaluation of friction in self-ligating brackets subjected to sliding mechanics: An in vitro study, Dent. Press J. Orthod. 16:107-115, 2011.
8. Badawi, H.M.; Toogood, R.W.; Carey, J.P.; Hei, G.; and Major, P.W.: Torque expression of self-ligating brackets, Am. J. Orthod. 133:721-728, 2008.
9. Janson, G; de Souza, J.E.; Alves, F.A.; Andrade, P. Jr.; Nakamura, A.; de Freitas, M.R.; and Henriques, J.F.: Extreme dentoalveolar compensation in the treatment of Class III malocclusions, Am. J. Orthod. 128:787-794, 2005.
10. Kim, K.M.; Sasaguri, K.; Akimoto, S.; and Sato, S.: Mandibular rotation and occlusal development during facial growth, J. Stomatol. Occ. Med. 2:122-130, 2009.
11. Sato, S.: Case report: Developmental characterization of skeletal Class III malocclusion, Angle Orthod. 64:105-111, 1994.
12. McLaughlin, R.P. and Bennett, J.C.: Bracket placement with the preadjusted appliance, J. Clin. Orthod. 29:302-311, 1995.
13. Sarver, D.M.: The importance of incisor positioning in the esthetic smile: The smile arc, Am. J. Orthod. 120:98-111, 2001.
14. Brandão, R.C.B. and Brandão, L.B.C.: Finishing procedures in orthodontics: Dental dimensions and proportions (microesthetics), Dent. Press J. Orthod. 18:147-174, 2013.
15. Câmara, C.A. and Martins, R.P.: Functional aesthetic occlusal plane (FAOP), Dent. Press J. Orthod. 21:114-125, 2016.
16. Epstein, M.B.: Benefits and rationale of differential bracket slot sizes: The use of 0.018-inch and 0.022-inch slot sizes within a single bracket system, Angle Orthod. 72:1-2, 2002.
17. Higa, R.H.; Henriques, J.F.C.; Janson, G.; Matias, M.; de Freitas, K.M.S.; Henriques, F.P.; and Francisconi, M.F.: Force level of small diameter nickel titanium orthodontic wires ligated with different methods, Prog. Orthod. 18:21-28, 2017.
18. Hardy, D.K.; Cubas, Y.P.; and Orellana, M.F.: Prevalence of Angle class III malocclusion: A systematic review and meta-analysis, Open J. Epidemiol. 2:75-82, 2012.
19. Hisano, M.; Chung, C.R.; and Soma, K.: Nonsurgical correction of skeletal class III malocclusion with lateral shift in an adult, Am. J. Orthod. 131:797-804, 2007.
20. Miura, F.; Mogi, M.; Ohura, Y.; and Hamanaka, H.: The super-elastic property of the Japanese NiTi alloy wire for use in orthodontics, Am. J. Orthod. 90:1-10, 1986.
21. Gravina, M.A.; Canavarro, C.; Elias, C.N.; Chaves, M.G.A.M.; Brunharo, I.H.V.P.; and Quintão, C.C.A.: Mechanical properties of NiTi and CuNiTi wires used in orthodontic treatment, Part 2: Microscopic surface appraisal and metallurgical characteristics, Dent. Press J. Orthod. 19:69-76, 2014.
22. Capistrano, A.; Cordeiro, A.; Siqueira, D.F.; Capelozza Filho, L.; Cardoso, M.A.; and Almeida-Pedrin, R.R.: From conventional to self-ligating bracket systems: Is it possible to aggregate the experience with the former to the use of the latter? Dent. Press J. Orthod. 19:139-157, 2014.
23. Woon, S.C. and Thiruvenkatachari, B.: Early orthodontic treatment for Class III malocclusion: A systematic review and meta-analysis, Am. J. Orthod. 151:28-52, 2017.
24. Hanashima, M.; Sakakibara, K.; Slavicek, R.; and Sato, S.: A study regarding occlusal plane and posterior disocclusion, J. Stomatol. Occ. Med. 1:27-33, 2008.
25. Philippe, J.: Treatment of deep bite with bonded biteplanes, J. Clin. Orthod. 30:396-400, 1996.
26. Creekmore, T.D. and Eklund, M.K.: The possibility of skeletal anchorage, J. Clin. Orthod. 17:266-269, 1983.
27. Kyung, H.M.; Park, H.S.; Bae, S.M.; Sung, J.H.; and Kim, I.B.: Development of orthodontic micro-implants for intraoral anchorage, J. Clin. Orthod. 37:321-328, 2003.
28. Gianelly, A.A.; Bednar, J.R.; and Dietz, V.S.: A bidimensional edgewise technique, J. Clin. Orthod. 19:418-421, 1985.
29. Giancotti, A. and Gianelly, A.A.: Three-dimensional control in extraction cases using a bidimensional approach, World J. Orthod. 2:168-176, 2001.
30. Gioka, C. and Eliades, T.: Materials-induced variation in the torque expression of preadjusted appliances, Am. J. Orthod. 125:323-328, 2004.
31. Siatkowski, R.E.: Loss of anterior torque control due to variations in bracket slot and archwire dimensions, J. Clin. Orthod. 33:508-510, 1999.
32. Franco, E.M.F.; Valarelli, F.P.; Fernandes, J.B.; Cançado, R.H.; and Freitas, K.M.S.: Comparative study of torque expression among active and passive self-ligating and conventional brackets, Dent. Press J. Orthod. 20:68-74, 2015.
33. Epstein, M.B. and Epstein, J.Z.: Dual slot treatment, Clin. Impress. 10:1-11, 2001.
34. Lin, J. and Gu, Y.: Preliminary investigation of nonsurgical treatment of severe skeletal Class III malocclusion in the per-

manent dentition, Angle Orthod. 73:401-410, 2003.
35. Ngan, P. and Moon, W.: Evolution of Class III treatment in orthodontics, Am. J. Orthod. 18:141-159, 2015.
36. Stellzig-Eisenhauer, A.; Lux, C.J.; and Schuster, G.: Treatment decision in adult patients with Class III malocclusion: Orthodontic therapy or orthognathic surgery? Am. J. Orthod. 122:27-37, 2002.
37. Tanaka, E.M. and Sato, S.: Longitudinal alteration of the occlusal plane and development of different dentoskeletal frames during growth, Am. J. Orthod. 134:1-11, 2008.
38. Almeida, M.R.; Almeida, R.R.; Oltramari-Navarro, P.V.; Conti, A.C.; Navarro, R.L.; and Camacho, J.G.: Early treatment of Class III malocclusion: 10-year long-term clinical follow-up, J. Appl. Oral Sci. 19:431-439, 2011.
39. Lee, H.C.; Park, H.H.; Seo, B.M.; and Lee, S.J.: Modern trends in Class III orthognathic treatment: A time series analysis, Angle Orthod. 87:269-278, 2017.
40. Akan, S.; Kocadereli, I.; and Tuncbilek, G.: Long-term stability of surgical-orthodontic treatment for skeletal Class III malocclusion with mild asymmetry, J. Oral Sci. 59:161-164, 2017.
41. Teixeira, A.O.B.; Medeiros, J.P.; and Capelli, J.: Orthosurgical intervention in adolescent patients with marked Class III skeletal dysplasia, Rev. Dent. Press Orthod. Facial Orthop. 12:55-62, 2007.

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