# Case Report

# Absolute anchorage with universal T-loop mechanics for severe deepbite and maxillary anterior protrusion and its 10-year stability

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**ABSTRACT** An adult patient with severe maxillary protrusion and deepbite who was congenitally missing two mandibular incisors was treated successfully by maximum retraction of the maxillary anterior teeth after extraction of the maxillary first premolars using a moment differential between the anterior and posterior segments created by a universal T-loop. Anterior teeth were moved with controlled tipping, and little anchorage loss of the posterior segments was experienced using the universal T-loop spring. Reduction of overbite was performed by absolute intrusion of both maxillary and mandibular anterior teeth. With retraction of the maxillary anterior teeth and recontouring of the mandibular canines, proper overjet and overbite were achieved. This report shows the 10-year stability of the case treated with the universal T-loop for the first time. (*Angle Orthod.* 2010;80:771–782.)

**KEY WORDS:** T-loop mechanics; Deepbite; Protrusion; Stability; Absolute anchorage; Congenital missing

#### INTRODUCTION

A deep overbite can be corrected by intrusion of anterior teeth, extrusion of posterior teeth, or a combination of both.<sup>1</sup> When a continuous archwire is used to correct deepbite, extrusion in the molar area with subsequent posterior rotation of the mandible may occur.<sup>2</sup> Clockwise rotation of the mandible can provide relative improvement of a deep overbite problem in the anterior region; however, it may worsen the Class II

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convex profile and also increase the relapse potential for adults.<sup>3–8</sup> Because the segmented arch can minimize extrusion of the posterior teeth,<sup>8</sup> it may be a more stable approach for deepbite correction than a continuous archwire technique when arch leveling by incisor intrusion is indicated.<sup>2</sup>

For the correction of protruded anterior teeth, premolar extraction followed by retraction of the anterior teeth is essential, and anchorage control is important. To control anchorage loss, headgears, intermaxillary elastics, transpalatal arches, tipback springs, and, more recently, temporary anchorage devices (TADs) have been used. In many cases, the patient's compliance and discomfort from appliance use may interfere with treatment effectiveness. Although TADs overcome these limitations and offer absolute anchorage,<sup>9–11</sup> a surgical procedure is unavoidable, and the location of the TAD is limited by the amount and quality of alveolar bone.<sup>12</sup> Additionally, in cases of TAD failure, alternative treatment options are needed.

The T-loop has been suggested as a mechanism to control anchorage movement during extraction space closure; the T-loop operates by producing differential moments between the anterior and posterior segments.<sup>13–16</sup> Desired tooth movement can be achieved by changing the angulation of the preactivation bends,<sup>13</sup> by altering the dimensions of the spring,<sup>14,15,17</sup> or by changing the position of the T-loop,<sup>18,19</sup> with no need for additional procedures such as TAD implantation. The universal T-loop was developed for all types of anchorage through a process by which the

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Figure 1. Pretreatment facial (A) and intraoral (B) photographs.

loop was located differently, with a uniform design. This was a departure from the pattern in which the conventional T-loop had different shapes according to the intertube distance or type of anchorage.<sup>19</sup> In this report we present the case of an adult with maxillary protrusion and deepbite who was congenitally missing two mandibular incisors; successful correction was accomplished by the segmented arch technique using the universal T-loop. We present this patient's records 10 years after treatment to demonstrate the stability of the treatment.

### **CASE REPORT**

A female, aged 19 years and 1 month, sought treatment for upper anterior dental protrusion. She had

no significant medical or dental history. Pretreatment records showed a convex profile and mentalis strain with protrusive upper anterior teeth (Figure 1). She had an excessive overjet (10.0 mm) and overbite (6.0 mm), with the two mandibular incisors congenitally missing. The mandibular incisors impinged on the maxillary palatal gingiva because of a deep curve of Spee (COS). The maxillary incisors were severely proclined, and mild arch length discrepancies were present in both arches. The molars and canines were in a Class I relationship (Figure 2).

The panoramic radiograph showed that all teeth were present except for two mandibular lateral incisors and the mandibular left third molar (Figure 3). Cephalometric analysis showed a Class I skeletal pattern with a low mandibular plane angle (SN to MP angle, 27.5°). The U1



Figure 2. Pretreatment dental casts. The mandibular incisors were impinged on the palatal gingiva because of the deep curve of Spee.

to SN angle of 126.5° reflected proclination of the maxillary incisors and resulted in an acute nasolabial angle of 88.5°. The upper lip was 6.5 mm and the lower lip was 3.8 mm in front of the Sn-Pog' plane. Vertical exposure of the maxillary incisors at rest was 4 mm (Table 1; Figure 4). Based on these findings, the patient



Figure 3. Pretreatment panoramic radiograph.

was diagnosed as skeletal Class I deepbite with upper anterior protrusion and congenitally missing two mandibular lateral incisors.

#### **Treatment Plans**

The treatment objectives for this patient were to achieve a normal soft tissue profile and to obtain ideal overiet and overbite. By correcting the protrusion of the maxillary anterior teeth, the lip incompetence would be eliminated and the acute nasolabial angle would be improved. This would lead to better facial esthetics and normal incisal and canine guidance.

The treatment plan to achieve these treatment objectives was established as follows: the maxillary anterior teeth would be retracted after extraction of the maxillary first premolars. The mandibular lateral incisors and canines would be replaced with the canines and premolars, respectively.

A maximum anchorage was essential to maintain a Class I molar relationship throughout the entire period of treatment. To replace lateral incisors and canines

Table 1. Cephalometric Measurements

Measurements	Pretreatment	Posttreatment	Retention (10 y)
SNA, °	83.5	82.0	82.5
SNB, °	81.5	81.0	81.0
ANB, °	2.0	1.0	1.5
Wits appraisal, mm	3.5	2.5	2.5
SN-GoGn, °	27.5	27.5	27.5
Anterior facial height,			
mm	117.9	118.7	120.9
Posterior facial height,			
mm	84.9	84.7	86.6
U1-SN, °	126.5	101.5	102.0
IMPA, °	94.5	91.5	91.5
U1 to Facial plane, mm	15.3	3.9	4.1
L1 to Facial plane, mm	4.2	2.2	1.9
Upper lip to Sn-Pog'			
line, mm	6.5	2.4	2.7
Lower lip to Sn-Pog'			
line, mm	3.8	1.6	1.5
Nasolabial angle, $^{\circ}$	88.5	102.0	99.5



Figure 4. Pretreatment cephalometric radiograph (A) and tracing (B).



Figure 5. The 0.017  $\times$  0.025–inch titanium molybdenum alloy (TMA) T-loop spring  $^{\rm 19}$  used in this case.

with canines and premolars, reshaping and reduction of tooth size would need to be performed.

#### **Treatment Progress**

The maxillary first premolars were extracted. All teeth were sequentially bonded or banded with 0.018  $\times$  0.025-inch preadjusted edgewise brackets (Roth-type prescription). To gain space for anterior align-



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Figure 6. Progress intraoral photographs: (A) Four months later, the maxillary anterior teeth were retracted with a T-loop and the mandibular anterior teeth were intruded using one-piece intrusion archwire. (B) Forces (vertical arrows) and moment (round arrow) produced by a one-piece intrusion arch in the mandibular. (C) Nine months later, the mandibular anterior segment was leveled, but labioversion was observed. (D) Fourteen months after the beginning of treatment, the extraction space was almost closed and an L-loop was inserted in the mandibular arch for torque control.







Δ,	Μα,	Μ <sub>β</sub> ,	F <sub>h</sub> ,	F <sub>v</sub> ,	M∝/F <sub>h</sub> ,	$M_{\beta}/F_{h}$ ,	(	$F/\Delta$ ,
mm	g-mm	g-mm	g	g	mm	mm	(M <sub>α</sub> −M <sub>β</sub> )/⊢ <sub>h</sub> ,	g/mm
0.0	1283.5	1288.7	17.1	-4.7				
0.5	1329.5	1448.0	49.5	-11.9	26.8	29.2	-2.4	64.8
1.0	1377.2	1561.3	77.6	-16.4	17.7	20.1	-2.4	56.2
1.5	1420.9	1672.5	105.4	-20.6	13.5	15.9	-2.4	55.6
2.0	1464.8	1780.9	133.4	-25.2	11.0	13.4	-2.4	55.9
2.5	1509.2	1884.2	160.9	-28.7	9.4	11.7	-2.3	55.0
3.0	1563.2	1983.9	188.9	-32.2	8.3	10.5	-2.2	56.0
3.5	1611.4	2076.1	216.4	-35.2	7.4	9.6	-2.1	55.0
4.0	1669.1	2170.4	244.1	-38.5	6.8	8.9	-2.1	55.4
4.5	1716.8	2256.6	272.4	-41.6	6.3	8.3	-2.0	56.6
5.0	1766.4	2343.2	300.7	-44.4	5.9	7.8	-1.9	56.6
5.5	1791.7	2425.4	329.6	-46.7	5.4	7.4	-1.9	57.8
6.0	1810.6	2505.8	358.2	-48.1	5.1	7.0	-1.9	57.2

Table 2. Forces and Moments According to Activation of 0.17 × 0.025 Inch Titanium Molybdenum Alloy Standard T-Loop Spring (B/L = 0.63)<sup>19</sup>

ment, the maxillary canines were retracted partially with a transpalatal arch and tipback spring to reinforce the anchorage. The mandibular teeth were aligned sectionally for segmental arch leveling.

Four months later, the maxillary anterior teeth were retracted with an A-type segmented T-loop (0.017  $\times$  0.025–inch titanium molybdenum alloy), which was Burstone's universal T-loop (Figure 5). The loop was located approximately 3 mm posteriorly in relation to the interbracket distance, keeping a B/L ratio of 0.63 to obtain a moment differential.<sup>18,19</sup> The anterior and posterior segments were stabilized with 0.017  $\times$  0.025–inch stainless-steel wire (Figure 6A). The pa-

tient was instructed to wear a short highpull headgear at night to counteract the excessive moment of the posterior segment. Since the cross-tube detached from the stabilizing wire of the anterior segment about 1 month later, the canine brackets were exchanged for Burstone's canine brackets, and new universal T-loop springs were fabricated.

The mandibular anterior and posterior segments were stabilized separately, and a one-piece intrusion archwire was attached to the mandibular first molars to intrude the anterior teeth (Figure 6B). Nine months later, the anterior segment was intruded and positioned lower than the posterior segment, but labiover-





Figure 7. Posttreatment dental casts.



Figure 8. Posttreatment facial (A) and intraoral (B) photographs.

sion of the anterior segment was observed (Figure 6C). To correct the axis of the anterior segment, an 0.016  $\times$  0.022-inch stainless-steel wire with a 7° lingual crown torque in the anterior region and L-loops between canine, first premolar, and second premolar was inserted to the lower arch (Figure 6D). The mandibular canines were interproximally recontoured several times throughout the treatment.

The T-loop was activated 3 mm initially (M/F alpha = 8.3, M/F beta = 10.5) and reactivated when a space of 1.5 mm was closed (M/F alpha = 13.5, M/F beta = 15.9), as seen in Table 2,<sup>19</sup> and this procedure was repeated a couple of times until the extraction space was closed (Figure 6D). After 10 months of retraction of the maxillary anterior segment, the T-loop was replaced with



Figure 9. Posttreatment panoramic radiograph.



Figure 10. Posttreatment cephalometric radiograph (A) and superimposed tracings (B).

a root spring of  $0.016 \times 0.022$ -inch stainless-steel wire for the control of angulation of root axis. The canine and second premolar were tied tightly to prevent opening of the extraction space during the root movement. As canting of the maxillary anterior teeth was noticed, a three-piece intrusion wire was constructed, and the intrusion force applied only to the right side.

After 26 months of treatment, proper overjet and overbite were achieved, and the fixed appliance was removed. For retention, fixed lingual retainers were bonded from second premolar to second premolar in the maxilla and from first premolar to first premolar in the mandible (Figure 7). The patient was requested to wear removable circumferential retainers 24 hours a day for the first 6 months and thereafter for 18 months at night only.

#### **Treatment Results**

The posttreatment facial photographs showed marked improvement of the facial profile, and the patient's smile improved. Protrusion of the maxillary anterior teeth was corrected, and a Class I molar relationship was achieved with proper overjet and overbite. As a result of the reshaping of the mandibular canines to incisors, normal incisal and canine guidance could be established (Figure 8).

The posttreatment panoramic radiograph confirmed root paralleling (Figure 9). The maxillary and mandib-

ular incisors were intruded 3.0 mm and 1.5 mm, respectively, and retracted 11.4 mm and 2.3 mm, respectively. Consequently, the overjet was reduced from 10.0 mm to 1.5 mm, and the overbite was reduced from 6.0 mm to 2.0 mm. The U1 to SN plane was decreased from  $126.5^{\circ}$  to  $101.5^{\circ}$  (Table 1). The movement of the maxillary incisors contributed to correction of the soft tissue profile and mentalis strain. Even though the anterior teeth were fully retracted in the maxilla, there was little movement of the molars anteriorly (Figure 10). After 10 years of retention, posttreatment stability of the occlusion was observed (Figure 11), and the lateral cephalometric radiograph and superimposition showed no marked skeletal or dental changes (Figures 10 and 12B). A minor space between the upper central incisors was observed even though a lingual fixed retainer had been bonded throughout the retention period (Figure 13).

## DISCUSSION

The universal T-loop has been recognized as an effective means to achieve desired tooth movement by differential moments between the anterior and posterior segments.<sup>13–20</sup> Although TADs have been widely used for anchorage reinforcement, there are unpredictable factors such as anatomical limitations and the possibility of failure. However, precise control of tooth movement is possible in a predictable manner with the



Figure 11. Facial (A) and intraoral (B) photographs 10 years after treatment.

T-loop spring by changing the dimensions,<sup>14,15,17</sup> shape,<sup>13</sup> or position of the T-loop.<sup>18,19</sup> According to Kuhlberg and Burstone,<sup>18</sup> eccentric positioning of a T-loop with a symmetric shape could be used to achieve a moment differential and maintenance of the moment differential as the spaces close, improving anchorage control and force system predictability. As it was modified to increase the preactivation moment according to the increase of intertube distance by adding continuous curvature to the horizontal leg, all kinds of space closure are possible with only one spring, regardless of intertube distance.<sup>16,19</sup>

Thus, we used a universal T-loop spring (Figure 5) and positioned it approximately 3 mm posteriorly (keeping a B/L ratio of 0.63) to retract and intrude the upper anterior teeth and to prevent posterior anchorage loss. A posteriorly positioned T-loop spring produces a greater moment to posterior teeth than to anterior teeth, and it also causes extrusive force on the posterior teeth and intrusive force on the anterior teeth.<sup>18,19</sup> The T-loop spring in this case was assumed to produce a M/F alpha of 8.3 and a M/F beta of 10.5 when the spring was activated 3 mm, and the M/F alpha and beta would increase with deactivation (Table 2).<sup>19</sup> During deactiva-



Figure 12. Panoramic (A) and lateral cephalometric (B) radiographs 10 years after treatment.

tion of the spring, however, the whole system of force can change by the movement of the teeth, requiring a self-corrective loop with proper compensation,<sup>17</sup> or the spring must be readjusted every month.<sup>20</sup> Because we used Burstone's universal T-loop, the spring was readjusted every visit and reactivated when the space of 1.5 mm was closed.

The patient was instructed to wear a short highpull headgear at night to cancel out the excessive moment exerted on the posterior teeth by production of distal root tipping moment (Figure 14) and consequently preventing mesial root movement of the posterior teeth. The vertical (extrusive) force on the beta position seemed to be balanced by bite force as it is known,<sup>19</sup> and the vertical (intrusion) force on alpha intruded the anterior teeth. From the superimposition of lateral cephalograms (Figure 10B), it is confirmed that the position of the maxillary first molar was maintained while the anterior teeth were retracted 11.4 mm and intruded 3.0 mm.

To correct a deep overbite in this case, intrusion of the incisors was indicated because of the significant exposure of maxillary incisors, deep COS, and no remaining growth. Intrusion of the incisors can be performed by the segmented arch or the continuous archwire technique.<sup>2,21–25</sup> One of the differences between the two methods seems to be whether the extrusion of posterior teeth is allowed or not. In terms of the long-term stability of deepbite treatment, extrusion of the premolar teeth by a continuous archwire would increase a patient's lower facial height, and this change would tend to relapse following treatment unless suitable growth occurred.<sup>3–7</sup> In contrast, other reports<sup>26,27</sup> have shown that vertical extrusion of premolars and molars gives rise to a stable change and that lower incisor intrusion frequently relapses to produce an increase in overbite. Considering these conflicting opinions, incisor intrusion seems to be a more stable approach if intruded incisors can be maintained. Therefore, both maxillary and mandibular incisors were intruded without extrusion of posterior teeth by the segmented arch technique, and fixed lingual retainers were bonded, including both sides of the premolars, to prevent relapse of the intruded incisors.

In many long-term studies of deepbite correction, several factors contributing to stability have been considered. The long retention period and the retainer design are of importance, while the relative stability of overjet plays a role in overbite stability as well.<sup>22</sup> Protrusion of the mandibular incisors during orthodontic correction of overbite<sup>28</sup> and increased curve relapse<sup>21</sup> can increase the possibility of overbite relapse. In terms of COS relapse, patients who were completely leveled posttreatment showed a significantly lower incidence of COS relapse than did those who were not.<sup>24</sup>

In our case, the amount of overbite relapse was 0.5 mm, which is similar to values quoted in previous reports.<sup>23,29,30</sup> The long retention period by a fixed lingual retainer may have played an important role in the stability of the overbite. The mandibular incisors were protruded right after intrusion, but this was corrected by stripping of the mandibular canines and a L-loop wire with lingual crown torque. Therefore, the COS could be flattened completely without protrusion of the mandibular incisors, which may also have contributed to the long-term stability. In addition, the size of the mandibular canines was decreased 1.4 mm by stripping, and the sum of the incisor ratio was changed from 4:3.26 to 4:2.92. Consequently, proper overjet and overbite and a Class I molar relationship could be achieved and maintained. The relationship of appropriate overjet and overbite may also have had a causal effect on posttreatment stability.

Posttreatment results showed good stability after 10 years; prevention of extrusion of the posterior teeth by the segmented arch technique and the long retention



Figure 13. Dental casts 10 years after treatment.



**Figure 14.** Forces and moments produced by a T-loop spring and a short highpull headgear. A posteriorly positioned T-loop spring produces a greater moment (round arrows) to posterior teeth than to anterior teeth, and it also causes extrusive force (vertical arrows) on posterior teeth and intrusive force on anterior teeth. A short highpull headgear was intended to counteract the excessive moment exerted on the posterior teeth by delivering a distal force (dashed arrow) above the center of resistance.

period with fixed lingual retainers seemed to contribute to this stability.

#### CONCLUSION

• A patient with deepbite and protrusion of the maxillary anterior teeth was treated successfully by maximum retraction and intrusion using a segmented arch technique with universal T-loop spring, and the treatment result was stable after 10 years.

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