This article has been peer reviewed.

Treatment of an Asymmetric Class III Malocclusion Using the Dynaflex CS2000 Appliance: A Case Report

By Kevin Scott Manzella, DDS, MS; Thikriat Al-Jewair, BDS, MBA, MSc, MS, FRCDC, ABO Dip.

Abstract: *Abstract: **Aim**: The present paper reports a case of a moderate Class III subdivision right malocclusion with maxillary transverse deficiency and ectopic mandibular second molars treated using a CS2000® appliance, NiTi Memoria® Leaf Spring Activated Expander (NiTi-MLSAE), and Titanol Uprighting Springs®. **Method**: A NiTi-MLSAE was used to expand the maxillary arch while Titanol Uprighting Springs® worked to upright ectopic mandibular second molars. The CS2000® appliance was then used to correct the unilateral Class III malocclusion. **Results**: Adequate molar uprighting and maxillary arch expansion were obtained within two months, while the Class III malocclusion was corrected in one month. **Conclusion:** This case report illustrates how an asymmetric Class III dental malocclusion can be efficiently treated using the CS2000 appliance following mandibular second molar uprighting utilizing Titanol Uprighting Springs®.*

Introduction

Smile symmetry and coincident dental midlines have been shown to be important aspects of overall smile esthetics.[1,2] Skeletal Class III patients often have midline deviations as a result of asymmetric mandibular growth.[3] Conventional treatment modalities used to correct unilateral Class III malocclusions can range from the simple use of intermaxillary elastics to orthognathic surgery techniques depending on case severity.[4] Temporary anchorage devices have proven useful in aiding distalization of mandibular buccal segments when placed in the buccal shelf of the sides needing distalization.[5,6] More recently, Vanlaecken et al. reported the successful use of interarch spring loaded modules (CS2000®, Dynaflex, St. Ann, MO, USA) in correcting mild to moderate Class III dental malocclusions without requiring patient compliance.[7]

The incidence of impacted mandibular molars in orthodontic patients ranges from 2-3% .[8] Diagnosis is typically not made until patients are 10-14 years of age.[9] Causes of mandibular molar impaction include ectopic follicle position, eruption path obstacles, primary failure of eruption,[10] and orthodontic appliances such as mandibular lip-bumpers.[11] Tipping and ectopic eruption of permanent mandibular molars has been associated with occlusal, dentoalveolar, and arch length complications.[12] Numerous treatment modalities for correcting such impactions have been reported in the literature including the pivot arm appliance,[13] brass wire technique,[14] nickel-titanium arch-wires,[15] Rect-spring,[16] Halterman appliance,[17] elastic separators,[18] T-loop springs,[19] and surgical molar uprighting techniques.[9] Titanol Uprighting Springs® (Forestadent, Pforzheim, Germany) made of a combination of stainless steel and nickel-titanium can also be utilized to accurately control mandibular molar uprighting.[20] Even when molars are not impacted, but only tipped, these techniques are useful in creating space when Class III dental correction is required.

The aim of this report was to present how an asymmetric Class III dental malocclusion can be efficiently treated using the CS2000 appliance following mandibular second molar uprighting utilizing Titanol Uprighting Springs®.

Diagnosis and Treatment Plan

A 13 year-old Caucasian female presented with a chief complaint of crowded teeth and a lower molar that was "growing in wrong." Clinical examination revealed a moderate Class III subdivision right malocclusion, quarter-cusp Class II cuspid on the left, with maxillary transverse deficiency resulting in constricted maxillary buccal segments (Figure 1). The family reported that her father had a "strong jaw." Her mandibular midline was shifted to the left 2.5 mm due to a functional shift of the mandible on closure. Posterior interferences were present when her jaw was placed in centric relation. An anterior open bite was present at the maxillary right lateral and canine regions. There was 1mm overbite and overjet at the central incisors. Her lower incisors were slightly retroclined (IMPA=85.3°), but in a normal horizontal relationship with the chin (L1-Apo=0.9mm). Both mandibular second molars were erupting in a mesioangular position (Figures 1, 2). She had a straight profile with a prominent chin and an obtuse nasolabial angle. Frontal analysis supports the existence of a functional shift, as her chin was deviated to the left of the facial midline. She had 90% incisal display on smile and a normal lower anterior facial height. The panoramic radiograph showed a root dilaceration of the upper right lateral incisor, normal TMJ anatomy, and no third molar buds developing. Cephalometric analysis indicated a Class I skeletal pattern (ANB=3.6°) with a prognathic maxilla (SNA=87°) and mandible (SNB=83.4°), and a normal vertical growth pattern (SN-MP=31.6°). Her CVM skeletal maturational assessment showed that she was at Stage 4 and passed the peak in growth spurt.

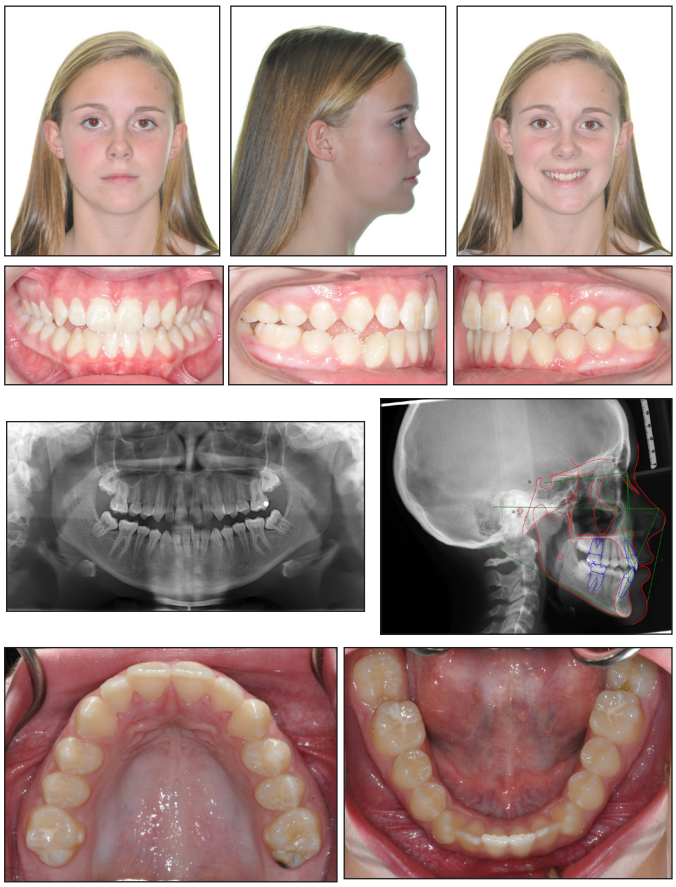

Figure 1: Initial Records

Treatment Objectives

The treatment objectives for this case were to maintain the facial profile, correct the transverse discrepancy, achieve a Class I molar and canine relationship with ideal overbite and overjet, and resolve the midline deviation. More specifically, the plan was to upright the tipped molars by distally tipping the crowns, creating space for distal movement of the dentition using the CS2000® appliance. Due to her prominent chin, care was taken in order to maintain lower lip support following Class III correction.

Treatment Plan

Following a comprehensive clinical and radiographic examination, a treatment plan was devised utilizing the NiTi Memoria® Leaf Spring Activated Expander (Ni-Ti MLSAE) to correct the transverse deficiency, Titanol Uprighting Springs® to upright the mandibular second molars, and the CS2000® appliance to correct the dental Class III malocclusion. This plan would alleviate the transverse discrepancy, upright the tipped mandibular second molars, and achieve a Class I occlusion with coincident midlines.

Treatment Alternatives

Treatment alternatives included maxillary expansion with a Hyrax expander and Class III dental correction using intermaxillary elastics. The parents were also given the option to resolve the transverse discrepancy now and delay treatment until growth is complete. Even though she presented as a skeletal Class I, the report of her father having a "strong jaw" prompted a discussion regarding potential future jaw growth. They were warned that future growth may not be favorable and that surgical intervention might be required to resolve any skeletal discrepancy that arises. The parents chose to proceed with treatment, understanding the risks of future mandibular growth.

Treatment Progress

A Ni-Ti MLSAE was placed and activated ten times at each monthly appointment until correction was obtained (Figure 2a).[21] No activations were performed upon cementation, as the leaf springs come fully compressed from the lab. The patient was evaluated one week after insertion, but no activations were performed. Intermolar expansion of 4mm was observed in two months. After adequate expansion was obtained, flowable composite was placed in the expansion screw housing to stabilize the appliance (Figure 2b).[21] This was followed by a passive retention phase of three months. Coincidently, segmental 0.016x0.022 NiTi archwires were placed on the mandibular arch utilizing 3M/Unitek's 0.018 Victory Series (MBT prescription) bracket system. Titanol Uprighting Springs® were placed to upright the left and right mandibular second molars (Figure 3). The uprighting springs were placed with a 90° bend in the stainless steel portion with a 3-5mm step. This step helped to prevent any extrusion of the molar during the uprighting process. Since distal crown tipping (not mesial root movement) was intended, a stainless steel ligature was not placed to connect the tipped molar to the anchorage unit. The molars were sufficiently uprighted in 1.5 months. The remaining teeth were then bonded and leveling and aligning was accomplished using 0.014 CoNiTi, 0.016 NiTi, and 0.016x0.022 SS arch-wires. Once maxillary and mandibular 0.016x0.022 stainless steel wires were placed, the CS2000® appliance was inserted with screws fully engaged in the housing nuts to prevent sliding (Figure 4). The Class III malocclusion and dental midline discrepancy was corrected in one month. The appliance was removed, and Class III elastics (1/4 inch; 6 ounce) were worn at night in order to maintain the correction during finishing and detailing the occlusion. Anterior box elastics (1/4 inch; 3.5 ounce) were used to close the anterior open bite.

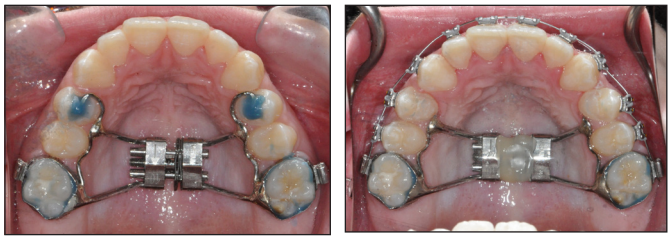

Figure 2: NiTi MLSAE at cementation (a) and stabilization appointments(b)

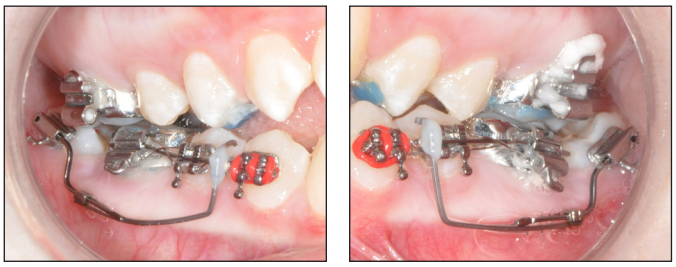

Figure 3: Placement of Titanol Uprighting Springs®

Figure 4: CS-2000® appliance in place for one month

Table 1 Pre and post-treatment cephalometric measurements

	Pre-Treatment	Post-Treatment
SNA	87	87.7
SNB	83.4	83.9
ANB	3.6	3.8
Wits	-1.2	-1.8
A-Na Perp (mm)	4.4	5.7
Pg-Na Perp (mm)	4.4	5.9
Co-A (mm)	78.7	76.6
Co-Gn (mm)	111.6	110.4
LFH (%)	65.6	66
Y-axis	57.6	57.5
FMA	27.1	29
SN-MP	31.6	34.3
FMIA	67.6	63.8
IMPA	85.3	87.2
Interincisal Angle	137.9	126.3
U1-SN (Degrees)	102.3	109.4
L1-APo (mm)	.09	1.9
U1-Na (mm)	1.8	2.8
Nasolabial Angle	122.7	121.3
U-Lip to E-plane	-2.7	-3
L-Lip to E-plane	-2.6	-1

Treatment Results

A Class I molar and canine relationship was obtained with ideal overbite and overjet. The transverse discrepancy was resolved (Figure 5). She now has coincident midlines and a more symmetric face as her functional shift was resolved. Her smile line was improved, and her buccal corridors were reduced with expansion. The majority of the A-P correction was due to mesialization of the maxillary molars and proclination of the maxillary anterior teeth (Figure 6, Table 1). There was some distalization of the lower arch into the space created by molar uprighting. Her lower lip gained support from the proclined maxillary anterior teeth and due to the fact that proper torque was maintained in the mandibular anterior teeth during the Class III correction (Figure 6). Most skeletal cephalometric numbers remained relatively constant following treatment. There was a slight increase in mandibular plane angle (Table 1) due to the Class III mechanics erupting the maxillary molars.

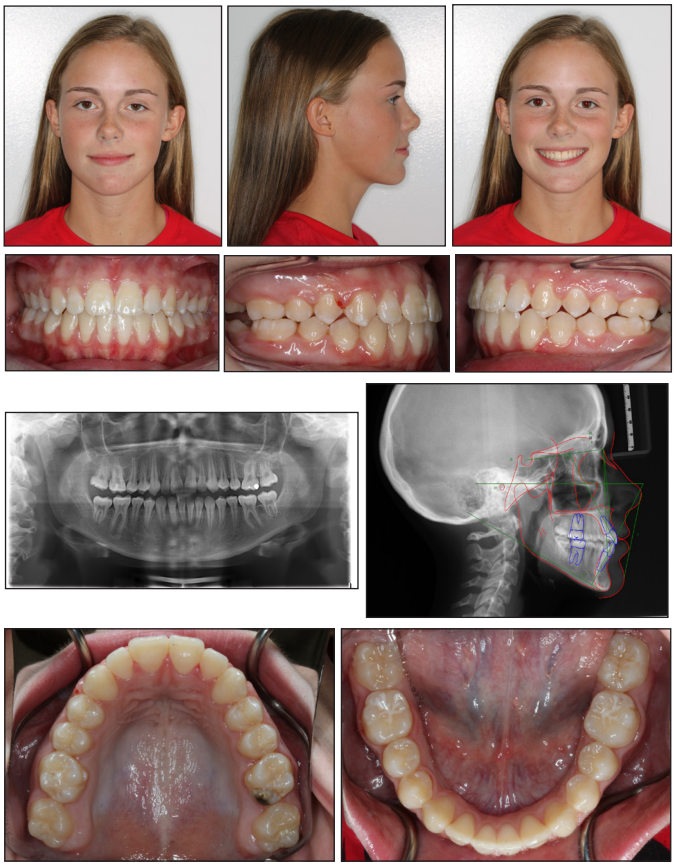

Figure 5: Final records

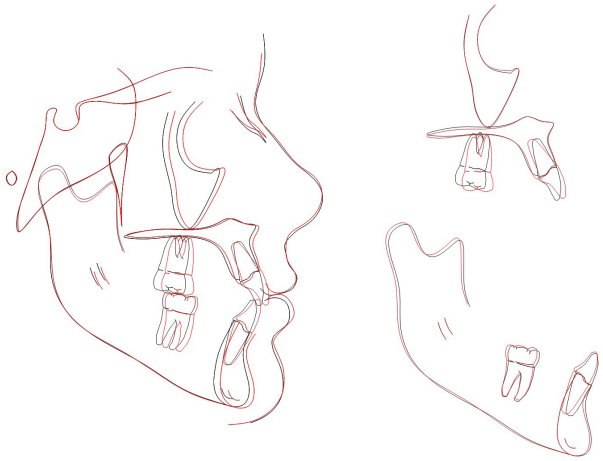

Figure 6: Initial (black) and final (red) superimpositions

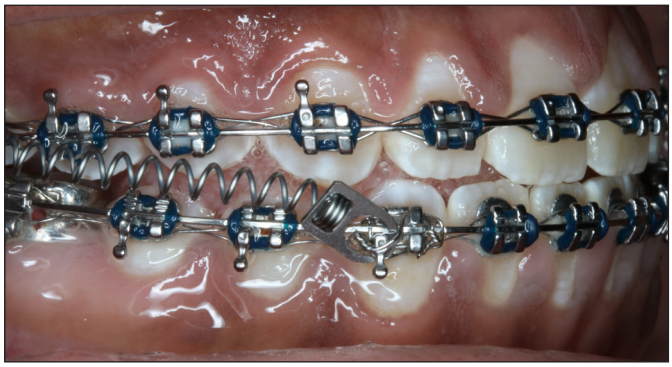

Figure 7: Modified "Mawaldi" technique to ligate the springs using a steel tie

Discussion

This case required careful treatment planning as it involved tipped mandibular second molars, an anterior open bite, and a dental Class III malocclusion. A Ni-Ti MLSAE was used to gain adequate expansion. Utilizing a molar uprighting technique that could distalize the mandibular second molars—allowing space for buccal segment distalization—while preventing molar eruption was critical. Uprighting mandibular molars often result in an extrusive movement of the teeth being uprighted. The Titanol Uprighting Springs® allowed for controlled uprighting, while also providing an intrusive force which prevented bite opening.

Few studies have reported on the use of the Ni-Ti MLSAE.[21,22] This appliance requires no at-home activations and has been shown to provide calibrated dental expansion at a rate of 1-1.5 mm per month.[21] More research is required to evaluate the skeletal and dental effects of this appliance.

The Titanol Uprighting Spring® is a NiTi-SE-stainless steel product used to upright molars. Depending on the technique used, it is capable of controlling the amount of molar extrusion/intrusion that occurs during the uprighting process. The system consists of a cross tube that is threaded onto a segmental archwire placed from canine to second premolar. The stainless steel arm of the uprighting spring is engaged into the cross tube distal to the canine and cinched. It is best to have a 0.017x0.025" SS or larger segmental archwire in place to stabilize the anchorage unit. The NiTi portion of the spring is inserted into the bracket bonded to the molar requiring uprighting. There is a sliding jig built into the system. This allows for the NiTi portion to be placed flush against the molar bracket before the sliding jig is crimped to prevent movement. Depending on the type of movement required, there are different placement geometries available. The first geometry involves placing a 135° bend in the stainless steel portion of the spring. This provides a 1 N intrusive force to the molar. The second geometry consists of an additional vertical step of 3-4 mm at a 90° angle in the stainless steel portion. This prevents extrusion of uprighting molars. In the same context, the third geometry allows for molar extrusion and uprighting by decreasing the step in the stainless steel portion.[23] The stainless steel segment of the appliance should be contoured to the arch form to ensure comfort and proper engagement of the molar bracket. If no distalization during the uprighting process is indicated, a stainless steel ligature should be placed from the molar to the most adjacent tooth in the anchorage segment. This will prevent space opening and encourage mesial root movement. If further activation is required during treatment, additional uprighting force can be introduced by bending a 30° bend distal to the sliding jig with a three-prong plier.

Quick and efficient Class III correction was needed to distalize the mandibular dentition into the space provided by molar uprighting. The CS-2000® device accomplished this as planned. The CS-2000® appliance includes coil springs with laser-welded eyelets that allow screw fixation to archwire housing nuts. The appliance can be utilized to correct both Class II and Class III dental malocclusions. The housing nuts are placed mesial to the maxillary molars and distal to the mandibular canines for Class III correction. While, in Class II scenarios, the housing nuts are placed distal to the maxillary canines and mesial to the mandibular molars. If complete screw engagement is accomplished on 0.016x0.022 stainless steel or larger archwires, the housing nuts are unable to slide on the archwire. If placed mesially on the archwire initially, they then can be unscrewed and moved distally in order to activate the spring at subsequent visits. If the tips of the screws are removed prior to placement, the housing nuts are allowed to slide passively on the archwire.[24] The manufacturer states that this appliance is easy to place, requires little to no maintenance, can provide up to 5mm of correction, and delivers 350 grams of low continuous force.[25] Compliance is often an issue when clinicians choose to use traditional intermaxillary elastics to correct Class III malocclusions. This system is beneficial in that it is fixed and therefore does not rely on patient cooperation. A study by Vanlaecken et al. evaluated 30 patients treated with the CS-2000® appliance for Class III correction.[7] The treated sample consisted of an even number of males and females ranging from 6-15 years of age. The average total treatment time was found to be 1.3±0.3 years. A matched historical control group was obtained from the Bolton-Brush Study to rule out changes due to normal growth. Serial cephalograms were utilized to determine skeletal and dental changes. It was found that A-point moved forward 0.8mm, and the mandibular base moved posteriorly 2.8mm. There was a downward and backward rotation of the mandible resulting in a 4.2mm increase in lower anterior facial height and 1.6° increase in the mandibular plane angle. Wits improved by 4.7mm with an average molar correction of 5.2 mm. It was reported that 69% of this improvement was due to skeletal change; the remaining correction was contributed to forward movement of the maxillary molars. The overbite was decreased by 1.5mm aided by maxillary and mandibular molar extrusions of 1.5 and 1.4 mm, respectively. The authors concluded that the CS-2000® appliance is capable of correcting mild-to-moderate Class III malocclusions. Corrections were mainly attributed to forward movement of the maxilla, backward and downward movement of the mandible, proclination of the maxillary incisors, mesialization of the maxillary molars, and distalization of the mandibular molars. It should be noted that these patients had tooth-born sagittal appliances on their maxillary arches and MSX-2000 appliances on their mandibular arches during their treatment.

Each CS-2000® appliance (springs, pivots, and screws included) is marketed at roughly $40 per side. In comparison to traditional intermaxillary elastics, this is a large financial investment. However, the CS-2000® appliance is less costly compared to other commonly used compliance free Class II correctors such as Forsus and Herbst appliances.

The authors use the CS-2000® appliance for both Class II and Class III correction. Initially, the manufacturer's suggested protocol was followed. However, many emergencies were observed, and more simple protocols were implemented. In our experience, the fastest, most reliable method of using the CS-2000® appliance involves only the spring portion of the set-up and a stainless steel ligature (Credit: Dr. Ilaf Mawaldi). For Class III patients, the spring is placed just as an elastic would be on the hooks of the mandibular canines and maxillary first

(or second) molars. For Class II patients, the spring is placed on the hooks of the maxillary canines and the mandibular first (or second) molars. The most important step when using this protocol is ligating the anterior loop of the spring to the archwire/bracket. A stainless steel ligature is placed through the loop of the spring (which is still engaged on the hook), and tied loosely around the archwire or bracket (Figure 7). The ligature must be loose enough to allow for the spring to move freely while the patient functions, but tight enough to prevent the spring from coming off the hook. In 2015, Lombardo et al. presented two case reports highlighting the use of the CS-2000® appliance in two 12-year-old Class II patients.[26] A similar simplified method of securing the CS-2000® springs was used. Instead of ligating the anterior segment of the spring to the maxillary canine hooks and securing with stainless steel ligatures, they used a stainless steel ligature to secure the hooks to a posted archwire.[26] Since the introduction of the CS-3000®—a more durable design—and the implementation of this new protocol, emergency visits and fractures have reduced. Furthermore, the simplified engagement technique requires much less chair time and is less costly, as there is no need to stock the pivots and screws.

This patient's profile was improved with treatment since her functional shift was resolved by expansion and Class III correction. Often times Class III patients have a concave profile and a functional shift due to improper anterior and/or posterior contacts. This patient reported that her bite felt more "natural" following treatment. As stated earlier, this family was warned that further Class III skeletal growth was possible in the future. The patient will be monitored until growth is complete to determine whether further treatment or jaw surgery is indicated. As the superimpositions indicated a slight increase in mandibular length throughout treatment, further Class III skeletal growth is likely (Figure 6).

References

1. Kokich VO, Jr., Kiyak HA, Shapiro PA: Comparing the perception of dentists and lay people to altered dental esthetics. *J Esthet Dent* 1999, 11(6):311-324.
2. Sarver D, Jacobson RS: The aesthetic dentofacial analysis. *Clin Plast Surg* 2007, 34(3):369-394.
3. Thiesen G, Gribel BF, Kim KB, Freitas MPM: Maxillofacial features related to mandibular asymmetries in skeletal class III patients. *J Oral Maxillofac Surg* 2017, 75(5):1015-1025.
4. Almeida GA: **C**lass III malocclusion with maxillary deficiency, mandibular prognathism and facial asymmetry. *Dental Press J Orthod* 2016, 21(5):103-113.
5. Jing Y, Han X, Guo Y, Li J, Bai D: Nonsurgical correction of a Class III malocclusion in an adult by miniscrew-assisted mandibular dentition distalization. *Am J Orthod Dentofacial Orthop* 2013, 143(6):877-887.
6. Ma QL, Conley RS, Wu T, Li H: Asymmetric molar distalization with miniscrews to correct a severe unilateral Class III malocclusion. *Am J Orthod Dentofacial Orthop* 2016, 149(5):729-739.
7. Vanlaecken R, Williams MO, Razmus T, Gunel E, Martin C, Ngan P: Class III correction using an inter-arch spring-loaded module. *Prog Orthod* 2014, 15(1):32.
8. Owen AH: **E**arly surgical management of impacted mandibular second molars. *J Clin Orthod* 1998, 32:446-450.
9. Kravitz ND, Yanosky M, Cope JB, Silloway K, Favagehi M: Surgical uprighting of lower second molars. *J Clin Orthod* 2016, **50**(1):33-40.
10. Andreasen JO PJ, Laskin DM: Textbook and color atlas of tooth impactions. Copenhagen, Denmark: Munksgaard; 1997.
11. Ferro F, Funiciello G, Perillo L, Chiodini P: Mandibular lip bumper treatment and second molar eruption disturbances. *Am J Orthod Dentofacial Orthop* 2011, 139(5):622-627.
12. Cernei ER, Mavru RB, Zetu IN: Axial modifications of permanent lower molars after premature losses of temporary molars. *Rev Med Chir Soc Med Nat Iasi* 2016, 120(1):178-185.
13. Warise TR, Galella SA: Controlled, rapid uprighting of molars: a surprisingly simple solution: the pivot arm appliance. *Int J Orthod Milwaukee* 2015, 26(4):9-14.
14. Perdigao JP, Lustosa RM, Tolentino Ede S, Iwaki Filho L, Iwaki LC: Uprighting bilateral impacted mandibular permanent second molars with the brass wire technique: a case report. *Int J Orthod Milwaukee* 2016, 27(1):37-40.
15. Lau CK, Whang CZ, Bister D: Orthodontic uprighting of severely impacted mandibular second molars. *Am J Orthod Dentofacial Orthop* 2013, 143(1):116-124.
16. Jun H, Lee HS, Song JS, Lee JH, Choi BJ, Kim SO: The Rect-spring: a new device for treating ectopically erupting permanent molars. *Pediatr Dent* 2014, 36(7):143-146.
17. Kennedy DB: Clinical tips for the Halterman appliance. *Pediatr Dent* 2007, **29**(4):327-329.
18. Rajesh R NV, Amit, S, Baroudi K, Sampath Reddy C, Namineni S: Treatment of ectopic mandibular second permanent molar with elastic separators. *Case Rep Dent* 2014, 2014:1-4.
19. Tuncay OC, Biggerstaff RH, Cutcliffe JC, Berkowitz J: Molar uprighting with T-loop springs. *J Am Dent Assoc* 1980, 100(6):863-866.
20. Rittinghaus T, Zernetsch H, Glasmacher B: Entwicklung von schichtweise ausgerichteten Faserverbundstrukturen. *Biomed Tech (Berl)* 2013.
21. Manzella K, Al-Jewair, T, Franchi, L: Correction of maxillary transverse deficiency using the NiTi Memoria Leaf Spring Activated Expander® in growing patients with permanent dentitions. *Journal of Clinical Orthodontics* 2018, **52**(3):148-156.
22. Gionolio A LC, Cherchi C: The Ni-Ti Memoria Leaf Spring Activated Expander. *OrthoNews* 2015, 1(38).
23. Zachrisson BU, Bantleon HP: Optimal mechanics for mandibular molar uprighting. *World J Orthod* 2005, **6**(1):80-87.
24. [https://dynaflex.com/laboratory-services/series-2000/cs-2000/]
25. CS2000 Class II and III Corrector. In. St. Louis, MO: DynaFlex; 2013.
26. Lombardo L, Carlucci, A, Cervinara, F, Siciliani, G: A new, no-compliance Class II correction strategy using nickel-titanium coil-springs. *J World Fed Orthod* 2015, **4**:40-49.

Dr. Kevin Manzella is a private practice orthodontist in Buffalo, NY. He received his DDS and MS Orthodontics degree from SUNY at Buffalo.

Dr. Al-Jewair is an Associate Professor and the Director of the Advanced Orthodontic Education Program at the University of Missouri - Kansas City. She is also the Chair-elect of the American Dental Education Association Section on Orthodontics. Dr. Al-Jewair obtained her MS and Certificate in Orthodontics from the State University of New York at Buffalo. She is a Diplomate of the American Board of Orthodontics and a Fellow of the Royal College of Dentists of Canada. Dr. Al-Jewair has published over 45 papers and book chapters on various topics including orthodontic treatment outcomes, oral appliance therapy for sleep-disordered breathing, and evidence-based and precision orthodontics.