Space Closure with Lingual Orthodontics: Different Mechanics for Different Smiles and Profiles

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Orthodontic treatment entails, on many occasions, the necessity for space closure mechanics. A case of crowding treated with extractions or a patient with multiple space malocclusion presents the orthodontist with a big challenge. It is well known today that esthetics involves not only good and functional occlusion but also the preservation or improvement of the patient’s smile and facial appearance.

Diagnosis

Diagnosis is an essential part of treating the spaced dentition and involves assessment of four aspects: skeletal, dental, esthetic, and miscellaneous factors such as habits, personality type, financial affordability, and the patient’s personal preferences and expectations (Fig 11-1).

Spaces should also be analyzed according to their duration and size and in relation to the shape of the involved teeth and papillae.

Fig 11-1 Skeletal, dental, esthetic, and other miscellaneous factors must be assessed during the diagnosis of the spaced dentition.
Duration of spaces
Spaces that have existed since the completion of the permanent den-
tition can indicate a discrepancy between tooth size and arch size, a
low frenum, or missing teeth. Continuous opening of spaces can
indicate imbalanced occlusal forces, a tongue thrust habit, or peri-
odontal problems.

Size of spaces
If spaces greater than 4 mm are present, tooth extraction can be con-
sidered as part of treatment because the closure mechanics may
involve a change in the patient’s profile. Small spaces can indicate a Bolton discrepancy between the sizes of the
maxillary and mandibular teeth.

Shape of teeth
The shape of the teeth must be assessed because spaces can appear,
for example, when the teeth have a peg shape or have been improp-
erly restored. Triangular teeth (such as are often found in adults after
periodontal intervention) may lead to a “black triangle” appearance
after all spaces are closed; therefore, reshaping of the teeth should be
considered (Fig 11-2).

Fig 11-2 Spaces are present be-
 tween the maxillary central and
lateral incisors. Note the conver-
gence of the maxillary central
incisor near the gingival line,
about 2 mm below the cemento-
ename junction, and the peg-sha-
ped lateral incisors.
Shape of papillae
A spaced dentition is usually associated with flat papillae or with the total absence of papillae. Spaces may also be associated with keratinized gingiva that, in some cases, will prevent the orthodontist from closing all spaces.

Treatment Planning
When choosing the proper treatment plan, the orthodontist should also determine the type of appliance to be used, the properties of the archwire, the mechanics of space closure, the anchorage requirements, and the type of retention. The prognosis of the end result should be determined, because the tendency for reopening of the spaces is very high, especially when the musculature of the face and lips and the function of the tongue are imbalanced. Permanent retention, continuous follow-up documentation (radiographs, photographs, and casts), and periodontal maintenance are prescribed after spaces have been closed.

Space closure mechanics is a great challenge for the orthodontist using the lingual orthodontic appliance. The lingual bracket is almost always bonded palatally to the center of resistance, which will cause a retroclination moment when retraction force is applied (Fig 11-3). The intrusion forces on the incisors that are caused by the contact between the mandibular incisors and the bite plane will exacerbate the retroclination moment in retroclined teeth (Fig 11-4). In the majority of cases, intrusion of the maxillary incisors is unwanted.
With aging, lips sag and as a result teeth will be unesthetically covered when an aging individual is smiling, speaking, and resting (Fig 11-5).

Biomechanical Principles
Knowledge of the biomechanical principles of lingual orthodontics will enable the orthodontist to close spaces and enhance facial esthetics. Correct initial diagnosis and definition of the treatment goals are essential to achieving the desired result. The relevant biomechanical principles will be discussed through the following three cases.

Case reports
Case 1
The patient had a Class I malocclusion, mildly spaced maxillary and mandibular anterior dentitions, acceptable tooth exposure during a smile, and a good smile line. There was a distal angulation of the maxillary central and lateral incisors. The overjet and overbite were small. The maxillary and mandibular anterior papillae were lacking, and alveolar bone loss and calculus were present. The lower third of his face was enlarged, but the tonus of the facial musculature was normal (Fig 11-6).
Case 1
The patient exhibits a Class I malocclusion, mildly spaced maxillary and mandibular anterior dentitions, acceptable tooth exposure during a smile, and a good smile line. There is distal angulation of the maxillary central and lateral incisors. The overjet and overbite are small. Maxillary and mandibular anterior papillae are lacking, alveolar bone loss is evident, and calculus is present. The lower third of the face is enlarged, but the tonus of the facial musculature is normal.

Case 2
The patient exhibited a Class I malocclusion, severely spaced maxillary and mandibular dentitions, and moderate tooth exposure during a smile. The maxillary central and lateral incisors showed distal angulation. The overjet and overbite were small. There was almost a total absence of maxillary and mandibular anterior papillae. The lower third facial height was normal, but he had hypertonic facial musculature (Fig 11-7).

Case 3
The patient had a Class III malocclusion, moderately spaced maxillary and mandibular anterior dentitions, and very little tooth exposure during a smile. She exhibited a negative overjet and an open bite tendency. The lower third of her face was enlarged, but the tonus of the facial musculature was normal. She had a pragmatic [AU: Should this be “prominent”?]chin, small upper maxilla [AU: “upper maxilla” ok, or just “maxilla”?], and a retrusive upper lip (Fig 11-8).
Case 2. The patient has a Class I malocclusion, severely spaced maxillary and mandibular dentitions, and moderate tooth exposure during a smile. Distal angulation of the maxillary central and lateral incisors is apparent. The overjet and overbite are small, and maxillary and mandibular anterior papillae are almost completely lacking. The lower third of the face is of normal height, but the patient exhibits hypertonic facial musculature.

Case 3. The patient has a Class III malocclusion, moderately spaced maxillary and mandibular anterior dentitions, and very little tooth exposure during a smile. There is a negative overjet and an open bite tendency. The lower third of the face is enlarged, but the tone of the facial musculature is normal. She exhibits a pragmatic [AU: Is “pragmatic” (meaning “practical”) the correct word? Or should it be “prominent”? Chin, a small upper maxilla [AU: “upper maxilla” ok?], and a retrusive upper lip.
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Controlling the torque
Extra torque is usually added when a retroclination moment is applied to the teeth during space closure. Extra lingual root torque on anterior incisors will not only procline the teeth but will also cause their extrusion. The moments that are caused by a change in the anterior torque have been described by Mulligan. The moments that are created by the addition of more torque to the anterior region will cause molar intrusion, incisor extrusion, and clockwise canting of the occlusal plane (Figs 11-9a and 11-9b). These movements are desirable, especially in cases where there is a great tendency for bite opening (cases 1 and 3) and when tooth exposure is limited (cases 2 and 3).

Tooth position can be controlled in lingual orthodontics by adding torque in the laboratory stage (up to 10 degrees of extra torque or 24 degrees in total) or by applying more torque on the wire. The best wires for torque control in lingual orthodontics are 0.017 × 0.017-inch Copper NiTi (Ormco, Orange, CA), 0.016 × 0.016-inch Direct (Ormco), 0.0175 × 0.0175-inch TMA (Ormco), 0.017 × 0.025-inch TMA, and 0.018 × 0.018-inch Titanol (Lancer, San Marcos, CA). Because of the small interbracket space in lingual orthodontics, wires with similar properties will apply much more force, and therefore stainless steel wires are rarely used for torque control. Wires should be left in slots tied with steel ligatures for about 4 to 5 months to enable the torque to be expressed.

Controlling the angulation
Spaced dentitions can have good tooth angulation (case 3) or distal crown angulation (cases 1 and 2). Bracket position should be controlled during the laboratory stage by increasing the overcorrection...
angulation values to the teeth to ensure that they will be upright after the space is closed. The addition of lingual root torque to the incisors will create a distal crown angulation, described by Andrews as the “wagon wheel effect.”

This tendency is even more pronounced in lingual orthodontics, because the interbracket space and the arch perimeter are much smaller than in buccal orthodontics. Special care should be taken to ensure that the proper tooth angulation will be incorporated in the laboratory prescription to ensure root parallelism at the end of treatment.

Controlling the anchorage
Space closure can be a considerable source of anchorage problems. Minimum anchorage cases (such as the maxillary arch of the patient in case 3) are difficult for the orthodontist treating with lingual orthodontics because of the retraction moments that are applied to the teeth while spaces are closed. Studies show better anchorage values for the posterior teeth during treatment with lingual orthodontics than with buccal orthodontics.

Extra torque can create too much force on the anchor unit, and therefore an enhancement of the anchorage should be considered. Stiffer wires (such as 0.016 x 0.022-inch stainless steel) should be used for long-span movement and resilient wires (such as 0.017 x 0.025-inch TMA) should be used in case of torque problems and open bite tendency. Second and third molars can be added to the posterior anchor unit. The orthodontist should also consider loading the anchor unit only in later stages, after full alignment of the teeth (seg-
mental technique). A combination of an 0.018-inch slot for the anterior teeth (canine to canine) and 0.022-inch slot for the posterior teeth is highly recommended to diminish the friction during sliding mechanics for space closure and to maintain the anterior torque at the same time. A bi-dimensional new wire, Wilcock Australian wire [AU: Please add manufacturer’s city, state/country], with dimensions of 0.018 x 0.025-inch for the anterior teeth (canine to canine) and 0.018-inch round for the posterior teeth (premolars and molars), can also be used to enhance torque control. The buccal segment can be added to the molar areas for anchorage enforcement and ? palatal/lingual arch, Nance button, QH, Hyrax etc. [AU: Please complete sentence]

Intramaxillary and intermaxillary elastics
Space closure involves not only horizontal forces but also vertical and in-out components. When extrusion is needed, class II or class III elastics can be prescribed. The point of force application has great significance in lingual orthodontics because of the small interbracket space in the horizontal direction and because the distance between the palatal and lingual cusps is smaller than the distance between buccal cusps.

The magnitude and direction of force generated by the elastics can be controlled by changing the point of force application and by modifying the size of the elastics. To attain a more horizontal vector, elastics should be placed on lateral incisors and on second or third molars (Fig 11-11). To increase the vertical component of the force, a

Fig 11-11 The magnitude and direction of force generated by the elastics can be controlled by changing the point of force application and by modifying the size of the elastics. To obtain a more horizontal vector, elastics should be placed on lateral incisors and on second or third molars.
buccal button should be considered. The effectiveness of the elastics is enhanced when the bite is opened (with a bracket bite plane). In such a case, lighter forces should be considered, because the bite opening is more common at the beginning of the treatment, when resilient wires are usually used.

The elastics most commonly used in lingual orthodontics are 0.3125-inch medium or heavy, 0.125-inch medium, and 6/11-inch medium. Class III elastics were used in the patient shown in case 3, to facilitate the advancement of maxillary teeth and retraction of mandibular teeth. Class II elastics were used in the patient shown in case 2, to help in extrusion of the anterior teeth. The patient was directed to wear them in a more vertical direction, between the maxillary canine and the mandibular molar.

Wires for space closure

Force can be altered by changing one of three parameters: modulus of elasticity, cross-sectional area of the wire, and length of the wire. The development of shape memory by thermally active wires such as Copper NiTi enables the orthodontist to achieve better control from the initial stage of the treatment. These wires are now available for lingual orthodontics in 0.017 x 0.017- or 0.017 x 0.025-inch sizes. When the material stiffness of different wires is compared relative to that of stainless steel (1.00 [about 25 x 106 psi]), beta-titanium wire, such as TMA, has a material stiffness of 0.42, while Copper NiTi (35 degrees) has a material stiffness of only 0.09.

![](Fig_11-12a.png) Different wires with different moduli of elasticity exhibit different deflection rates under load. [AU: No scales or units of measurement are shown for the load (stress) or the deflection. Is this just a generalized statement (e.g., “Generally, stainless steel exhibits more deflection under stress than nickel-titanium”), or is it based on measured values? If the latter, these values should be added to the figure. Also, why are there two lines for nickel-titanium?]
Full engagement of rectangular wire in the lingual bracket slot can be very difficult. The 0.018-inch slot enables the orthodontist to fill the slot with smaller wires. Because the degrees of freedom between the 0.018-inch slot and a rectangular wire are 7.0 degrees in 0.017 x 0.017-inch wire and 5.5 degrees in 0.017 x 0.025-inch wire, torque should be added to achieve the desired inclination of the teeth.

Extension of the length of the wire by creating loops may cause the patient to experience discomfort, speech problems, and irritation of the tongue. Use of the segmental technique is highly recommended in patients in whom the force levels should be diminished. Lengthening the wire will lead also to an increased moment (Moment = Force x Distance) and consequently to greater risk of rotation. When spaces are wide (as in case 2), a steel ligature should be used to secure the wire in the slot, and antirotation ties could be added as well.
Fig 11-13 Special attention should be given to patients in whom the contact between the mandibular anterior teeth and the lingual brackets in the maxillary anterior teeth can cause unnecessary trauma to the teeth and a proclination moment.

Periodontal Considerations
Spaces in the dentition can be accompanied by periodontal disease and bone loss. Special attention should be paid to lingual orthodontics patients in whom the contact between the mandibular anterior teeth and the lingual brackets in the maxillary anterior teeth can cause unnecessary trauma to the teeth and a proclination moment (Fig 11-13). Use of a posterior bite plane is recommended in these patients.

Lack of papillae also can create an esthetic problem. Adequate alveolar bone height, upright tooth angulation, root proximity, and a square tooth shape are essential for preservation or regeneration of the papillae. A proper laboratory prescription for indirect bonding, along with careful and frequent oral hygiene control, led to the regeneration of the papillae in all three patients shown in cases 1 to 3.

Conclusion
Three patients with spaced maxillary and mandibular dentitions were presented. Two were treated with lingual orthodontics in both arches (cases 2 and 3) and one was treated with a mandibular buccal appliance and a maxillary lingual appliance (case 1). Each case demonstrates a different diagnosis, different mechanics, and different etiology. All patients showed improvement in the esthetics of the face and the smile. The spaces were closed, and good occlusion was achieved (Figs 14 to 17).
Completion of space closure in cases 1, 2, and 3, respectively. The smiles and profiles have improved tremendously and good occlusions have been achieved.
Fig 11-17 The posttreatment smiles of the patients in cases 1 (bottom right), 2 (top), and 3 (bottom left) show great improvement. [AU: There was no legend. Is this ok?]
References