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ANTERIOR AND CANINE RETRACTION: THE GJESSING UNIVERSAL RETRACTION SPRING* Part two

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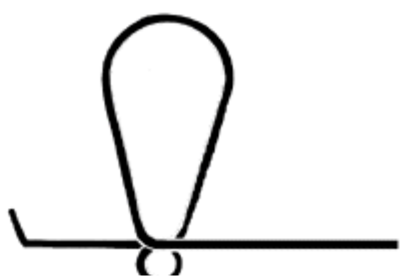
Of the non-frictional methods (closing loop mechanics) for the retraction of permanent canines and upper incisors, the Gjessing retraction spring is becoming increasingly popular among clinicians. As already stressed in part 1, closing loop mechanics for canine retraction show several advantages when compared to sliding mechanics:

- Absence of friction between the wire and the bracket slot;
- Possibility of clinically evaluating the force magnitude;
- Possibility of anticipating and controlling the M/F ratio at the canine bracket and at the posterior anchorage unit during retraction.

Poul Gjessing's (PG) Universal Retraction Spring is a prefabricated and precalibrated spring, using 0.016"x 0.022" stainless steel wire. This allows it to be used in both 0.018" slot and 0.022" edgewise systems [1,2].

The force system delivered by the spring has been calibrated experimentally by means of an electronic test apparatus that is able to register the moment to force ratio (M/F) generated for each activation unit. Spring design is characterized by an ovoid double-helix loop extending 10 mm apically (Fig. 2). This configuration allows for incorporation of additional wire with a consequent decrease in load defection rate (F/D).



A smaller loop is inserted occlusally to lower the level of activation on insertion in the bracket of the canine. This loop is modeled so that the activation is in the same direction as it was originally wound which leads to an additional reduction in F/D. The mesial and distal extensions of the spring show precalibrated angulations in the vertical plane (alpha, anterior angulation, and beta,

posterior angulation) and antirotation angulations in the horizontal plane. According to Gjessing[1,2] , bodily translation is the ideal tooth movement during canine retraction. As a pure horizontal force (F) applied at the bracket of the canine results in distal tipping and distal rotation of the tooth, it is necessary to add an antitip moment (M1) in the sagittal plane and an antirotation couple (M2) in the vertical plane. From a biomechanical point of view, translation is obtained when the value of M1/F and of M2/F ratios correspond respectively to the vertical and to the horizontal distances from the bracket of the canine to the center or resistance (CR) of the tooth. Bodily movement of a permanent canine with average root length and normal alveolar bone height can be induced when the antitip M/F ratio is 11 mm and antirotation M/F ratio is 4 mm. Gjessing[1,2] stressed that clinical experience has shown that the value of the antirotation M/F ratio should be increased to 7 mm to compensate for variations in the morphology and in the buccal inclination of the root. As for the initial force level for canine retraction Gjessing[1,2] suggests applying 100 gm. The application of such a low level of distalizing horizontal force allows for improved control of the canine movement, increased anchorage control and protection of the periodontal tissues of the tooth against iatrogenic damage. Clinically, a horizontal force of 100 gm is reached when the two wires of the ovoid double-helix loop of the spring are slightly separated one from another (Fig. 4).

On average, 1.2 mm of space closure is obtained with this activation in four weeks. During this period the horizontal force decreases from 100 gm to 40 gm while the intrusive vertical force on the canine increases up to 12 gm. An initial horizontal force of 100 gm generates an antitip M/F ratio of 9 mm at the point of the applied force. The initial canine movement is therefore a controlled tipping. The initial antirotation M/F ratio is 5 mm. After only 0.3 mm of deactivation of the spring, the antitip M/F ratio increases to 10-11 mm, thus producing translation. When the spring is completely deactivated, the antitip M/F ratio is 18 mm. This value produces uprighting of the canine root that compensates for the initial controlled tipping. Bodily movement of the canine is therefore obtained by a combination of controlled tipping, followed by translation and uprighting.The beta moment is incorporated in the distal extension of the spring by means of an experimentally derived curvature. The magnitude of the beta moment should be able to counteract the extrusive force induced by the alpha moment at the canine, by means of an intrusive force. The design of the posterior curvature allows for a uniform distribution of the beta moment to the buccal teeth. Light vertical forces (extrusive at beta position and intrusive at alpha position) are still produced, as alpha and beta moments show different magnitudes. However, these vertical forces are insignificant from a clinical standpoint. Clinical evaluations of the PG Universal Retraction Spring have also revealed that the second premolar and the first molar move mesially in a translatory manner without any unwanted side effects such as extrusion or rotation.

As for clinical applications of the PG Universal Retraction Spring for canine retraction, Gjessing suggests the following steps[1,2] :

1. Levelling of the buccal segments including the permanent canine.

The spring is constructed to resist tendencies for tipping and rotation during canine retraction. It does not correct existing rotations and/or extreme deviations in inclination of the tooth. Therefore levelling of the buccal segments, including the canine, second premolar, first molar and eventually the second molar is strongly recommended prior to insertion of the spring.

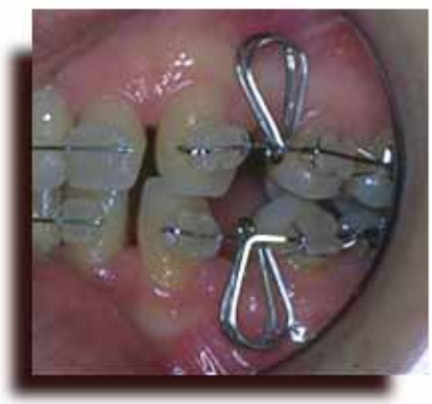
2. Adjustment of labiolingual spring inclination.

The correct labiolingual position of the spring is obtained by positioning of the double helix manually followed by twisting of the posterior extension with two Tweed pliers.

3. Bracket engagement.

The anterior extension of the spring is engaged in the canine bracket (fig. 3). The posterior extension is engaged into the brackets of the second premolar and the first molar. In this way it is possible to achieve optimum transverse control of the canine and good alignment of the canine, second premolar and first molar after retraction. The anterior extension is ligated into the slot of the canine bracket and it is pulled anteriorly with a Weingart plier until the small occlusal loop of the spring is in contact with the distal aspect of the canine bracket. The mesial leg is then bent gingivally with the same plier.

4. Activation.



The spring is activated by pulling the posterior extension distally to the molar tube with Weingart pliers until the two loops separate activates the spring.

Variations in the anatomy of the root or alterations in spring configuration during clinical management may result in a reduced distal inclination of the root of the retracted canine. This is compensated for after completed retraction by modifying the spring with an intraoral activation: a three-cone plier is placed on the posterior extension near the double helix to produce a V-bend in the buccal winding of the wire. The alpha moment is increased to a magnitude of approximately 1500 gm/mm which is ideal for uprighting. In rare instances minor rotations of the canine may occur which can easily be corrected with lingual elastics after retraction is completed.

The teeth in the posterior segment generally offer good resistance to mesialization even without the use of auxiliary systems to increase anchorage. In fact, the magnitude of the M/F ratio at beta position generates translation during retraction. However, in instances in which maximum anchorage is required, it is advisable to reinforce anchorage with appliances such as a transpalatal arch slightly activated in distal rotation[3].

Gjessing's retraction spring for upper incisors

Distalization of the upper incisors after canine retraction represents one of the most critical phases during space closure in premolar extraction cases. The correct positioning

of the upper incisors is essential for function, esthetics, and stability of treatment results[4]. Consequently, the force system applied with fixed appliances should be closely evaluated from a biomechanical standpoint.

According to Gjessing[2,4] , since most Class II cases show dento-alveolar deep bite due to overeruption of the incisors, the force vector for retraction of the maxillary incisors should be oriented in a backward and upward direction through the common center of resistance of the four maxillary incisors in order to produce bodily movement. Pedersen et al. [5] demonstrated that the common center of resistance of the four maxillary incisors is located 9 -10 mm gingival and 7 mm distal to the center of the lateral incisor bracket. Horizontal translation of the incisor segment (with average root lengths and normal marginal bone level) can be obtained with a spring that is able to produce a M/F

ratio of 9-10 mm at the lateral incisor bracket.

This value is somewhat less than the M/F ratio of 11 mm required for translation of the canine. However, experimental analysis on the PG spring has shown that an increased distance between the lateral bracket and the molar tube when compared to the distance between the brackets on the canine and on the second premolar, results in a decrease in the M/F ratio[4]. Thus, the PG spring for canine retraction can also be used for retraction of the upper incisors and for this reason it is also called "PG universal retraction spring"[2] (fig. 5). The activation of the spring follows the same principles as for canine retraction. The initial horizontal force developed by the spring is about 100 gm per side. The choice of such a force level for incisor retraction is based primarily on the analysis of the vertical forces and of the M/F ratios produced by the spring with different initial horizontal retraction forces.

The intrusive vertical force induced by the beta moment on the incisors should overcome the extrusive force generated by the alpha moment.

The analysis of the load/deflection curve at alpha position shows that after about 1.2 mm of space closure (which can be obtained after 4 weeks), the horizontal force reduces from 100 gm at the time of the initial activation to 30 gm before reactivation. At the same time the intrusive force increases from 9 gm to 23 gm per side. Moreover, at alpha position two different moments are generated by the alpha activation and by the intrusive force respectively. The two moments have the same direction as the intrusive force is located anterior to the center of resistance of the incisor segment. Therefore the total moment at alpha position is calculated by adding the two moments. At the initial activation, the M/F ratio at alpha position is about 7 mm, a value that is able to induce a controlled tipping of the maxillary incisors. After only 0.4 mm of deactivation, the M/F ratio increases to 10 mm and until the next reactivation the values for this ratio allow for an uprighting of the anterior segment.

As for the M/F ratio at beta position, the moment produced by the beta activation of the spring is directed opposite to the moment generated by the extrusive force that is located at an assumed distance of 10 mm posterior to the center of resistance of the posterior segment. Therefore at beta position the total moment is calculated by subtracting the two moments. During the deactivation of the spring, the magnitude of the M/F ratio at beta position is able to produce translation or even distal inclination, thus permitting good control of the posterior anchorage. The magnitude of the extrusive vertical force at the posterior segment is so low that it is counterbalanced by the occlusion.

With regards to the clinical application of the PG spring for incisor retraction, Gjessing suggests[2,4] the following steps:

1. Use of lateral incisor brackets with vertical slots (Broussard-type) and triple tubes for the upper molars.

2. Alignment of the incisor segment with a continuous levelling arch wire inserted in the gingival tube of the molar during the final phase of canine retraction (PG canine retraction spring can be attached to the occlusal tube).

3. The anterior and posterior segments are consolidated with sectional stabilizing arches made from heavy rectangular wires with occlusal bends close to the mesial and distal aspects of brackets and occlusal tubes in order to avoid reopening of spaces. The posterior anchorage may be reinforced with a passive transpalatal arch.

4. A 90° twist in anterior extension of the spring 3 mm in front of the small circular tube is made using a Tweed plier. The twisted extension is angulated 105° occlusally to reduce "the play" between the vertical slot and the wire.

5. The posterior extension is first inserted in the gingival tube and then the anterior extension is placed in the vertical slot of the lateral incisor, pulled occlusally to the maximum and locked by a mesial bend with Weingart pliers.

6. Pulling the posterior extension distally through the molar tube with a Weingart plier until the two helices of the double loop separate slightly activates the spring. The spring is secured in this position with a gingival bend distal to the molar tube. Reactivation should be done every 4-6 weeks.

CLINICAL CASE

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