Canine retraction in orthodontics: A review of various methods

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Abstract:
In orthodontic space closure procedure, retracting the canines separately in the first step and reducing the tendency of the maxillary molars to displace forward is known as separate canine retraction or “two-step” technique of retraction. Canine retraction mechanics is generally divided into sliding (frictional) mechanics and loop (frictionless) mechanics. Methods of canine retraction in sliding mechanics are; elastic modules with ligature, elastomeric chains, closed coil springs and in loop mechanics the methods are; PG canine retraction spring, Burstone T loop attraction spring, opus loop, mushroom loop and rectangular loop. Extra oral methods include direct head gear retraction and other methods include rapid canine retraction through distraction of periodontal ligament and retracting the canine with rare earth magnets. Other than fixed appliances, removable appliance which are used for retracting canines are; U loop canine retractor, helical canine retractor, buccal canine retractor, palatal canine retractor, supported and self supported canine retractors. Thus, depending upon the techniques employed, a number of procedures are used for the retraction of canine. The individual operator must choose the method of preference to treat the malocclusion which requires desired movement of teeth with minimal time to produce an aesthetic and functional occlusion.

Key words: canine retraction, orthodontics, methods, frictional, frictionless, mechanics.

Introduction:
In orthodontic therapy extractions are frequently indicated to correct severe crowding, to retract the anterior teeth and to correct molar mal-relationships or to modify the facial profile. The most common mechanism for making retraction space available involves the extraction of first premolar in each quadrant. After leveling, there are two general approaches of retracting anterior teeth with minimal mesial displacement of the maxillary first molar. The most common approach is a sequential procedure in which the canines and incisors are retracted in two separate steps. In the first step, the canine in each quadrant is retracted to full contact with the tooth distal to the extraction space. In the second step,
the canines are fastened to the teeth distal to them. The resulting grouping is then used as a single anchorage unit to retract the incisors. This procedure has been called the “two-step” technique. In retracting the canines separately in the first step, the load on the posterior teeth is lower, thus reducing the tendency of the maxillary molars to displace forward. In the second step, the posterior segments which are now buttressed by the incorporation of the canine are pitted against the reduced resistance of the incisors alone. However, closing space in two steps rather than one might make treatment take longer. Also, when canines are retracted individually, they tend to tip and rotate more than when the anterior teeth are retracted as a single unit, thus requiring additional time and effort to relive and realign. Therefore, an alternative approach called “en-masse retraction” has come into use in which the incisors and canines are retracted as a single unit. One therapeutic technique that uses this approach is the MBT system developed by Bennett and McLaughlin. This en-masse technique has recently gained popularity because of its mechanical simplicity. But in theory, it might be expected to tax the posterior anchorage more than the two-step technique. So, the space closure should be individually based on the diagnosis & treatment plan and selection of any method should be based on desired tooth movement.

Retraction mechanics is generally divided into:
1. Sliding (Frictional) mechanics involves either moving the brackets along the arch wire or sliding the arch wire through bracket & tube.
2. Loop (Frictionless) mechanics involves movement of teeth without the brackets sliding along the arch wire but with the help of loops.

Methods of canine retraction:
Methods of canine retraction in sliding Mechanics:
1. Elastic modules with ligature
This method of retraction has been popularized by Bennett and McLaughlin. Elastic modules are commercially available in various colors. (Fig. 1) A single elastic module is attached to the canine by ligature wires extending from the molar. These elastic tiebacks are activated twice their original size to generate approximately 50-100 gm of force. Bennett and McLaughlin found .019” x .025” rectangular wires in .022” slots to be most effective, providing maximum rigidity, while allowing adequate freedom for sliding. The tiebacks are replaced every four to six weeks.

2. Elastomeric Chains
Elastomeric Chains (e-chains) can be used for canine retraction. (fig. 2) They are available in configurations of closed loop, short filament and long filament chains. (fig. 3) Advantages of e-chains are that they are inexpensive, relatively hygienic and can be easily applied without arch wire removal and do not depend on patient cooperation. But, they absorb water & saliva and permanent staining occurs after few days in oral cavity. Tooth movement, pH and temperature change, fluoride rinse, salivary enzymes & masticatory forces cause...
deformation, force degradation and relaxation. Claire Nattrass, Anthony J. Ireland\(^2\) found that Elastomeric chain was affected by both temperature and environment (water, soft drinks and turmeric solution). E-chains should be changed at intervals of 4-6 weeks.

Fig.2: E-chains

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3. **Closed coil springs**
   They were introduced in 1931. They are made of various materials such as stainless steel, Co-Cr-Ni (Cobalt-Chromium-Nickel) alloy and Ni-Ti (Nickel-Titanium).
   
   **a. Stainless steel coil springs**
   Before stainless steel, they were available in precious metals. They apply more predictable level of force than force elastics. (fig. 4) They are easy to apply but have high load deflection rate as compared to Ni-Ti coil springs, so as space closes, some force degradation occurs due to lessening activation.

   **b. Ni-Ti close coil spring**
   R. H. A. Samuels and Rudge\(^3\) found that Ni-Ti coil springs produce more consistent space closure than elastics. (fig. 5) They are especially indicated if large spaces need to be closed or if there are infrequent adjustment opportunities. They are available in two sizes – 9 mm & 12 mm. Springs should not be extended beyond manufacturer’s recommendation. (22mm for 9 mm spring, 36 mm for 12 mm springs). They deliver constant force till the terminal end of deactivation stage is reached. The advantages of these springs are that they can be easily placed and removed without arch wire removal and do not need reactivation at each appointment; therefore patient cooperation is not needed. But, they are relatively unhygienic as compared to elastic system.

Fig.3: Configurations of elastic chain: closed, short and long filament chains

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Fig.4: Stainless coil springs

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Fig.5: Ni-Ti coil springs

Fig.5: Ni-Ti coil springs
Problems during sliding mechanics with elastics or coil springs: During retraction, occlusal interferences can hinder canine distalization. Friction and binding can occur due to improper angulation of canine bracket to wire and excessive force may be produced. Other than this rotation of canine (mesio-buccal) and molar (dista-buccal) can occur.

Methods of canine retraction in Frictionless Mechanics:
1. PG retraction spring

The PG universal retraction spring was introduced by Poul Gjessing of Denmark in 1985. It is made from 0.016” x 0.022” stainless steel wire. (Fig. 6) It is designed for controlled retraction of either canines or upper incisors. No clinical alterations of the spring is needed and force system produced is independent of inter bracket distance. The predominant active wire element is the ovoid double helix loop extending 10 mm apically.

Activation to 140 to 160 gm is obtained by pulling it distal to the molar tube until the two sections of the double helix are separated by 1 mm. Activation is repeated every 4 weeks, and the canine is expected to undergo approximately 1.5 mm of controlled movement with each activation. The Disadvantages of PG springs are that it is bulky and the depth of the buccal sulcus limits the height of the pear.

Burstone T loop attraction spring

It is a composite TMA 0.018”-0.017” x 0.025” retraction spring. (Fig. 7) A 0.018” round T spring is welded directly to a 0.017” x 0.025” base arch. The basic element of the spring is a prefabricated highly standardized universal spring, which could be used on both the right and left sides. These prefabricated versions have to be pre-activated as per a prescribed template.
Neutral position: The anterior and posterior extensions of the spring are “twisted” to bring each level to its respective attachment on the occlusal plane. In this position, it has zero horizontal force. (fig. 8) The horizontal force is produced by pulling the “T” open from this position.

Spring Pre-activation: Before the spring is inserted in the moth it needs to be preactivated. A curvature is bent in the occlusal part of the spring. This part of the spring may deform during activation and therefore needs to be over bent and followed by trial activation. Then remove the excess curvature. The ears in the gingival part of the T-spring are opened at some angle to the occlusal vertical arms so that the neutral position is correct. Then trial activation is done and the T-spring is rechecked on the template which is a guide for the required angulation.

To determine the amount of distal activation, the following formula is used to establish the spring length.

\[ L = I.T.D. - Activation. \]

Where, I.T.D. is the inter-tube distance from the mesial of the molar tube to the canine auxiliary tube and the Activation is the amount of the activation of the spring. L is the spring length, B is L/2 and B is the distance from the center of the T-loop to the 90 degree band at the canine bracket position (alpha position).

The spring is activated 6 mm. and delivers approximately 201 gm. of distal force at the start of retraction. After the canine moves distally by 1 mm, the force decreases to 168 gm. At a full 6mm of activation, tooth movement occurs in three phases: tipping, translation and root movement.

Opus loop

It was introduced by Raymond E. Siatkowski. It is made of are primarily 0.016” X 0.022” Stainless Steel, or 0.018” X 0.025” Stainless Steel or 0.017” X 0.025” TMA wires. It can be used for en-masse retraction of all anterior teeth with 018” slot. The design of the opus loop calls for an off-center position with the loop 1.5mm from the mesial (canine) bracket. (fig. 9) It is activated by tightening it distally behind the molar tube and can be adjusted to produce maximal, moderate or minimal incisor retraction, but like all closing mechanisms with a long range of action, must be monitored carefully. It is capable of delivering a non-varying target moment to force (M/F) ratio within the range of 8.0 to 9.1 mm inherently without adding residual moments via twist or bends (commonly gable bends) anywhere in the arch wire or loop before insertion. In spite of these advantages, the opus loop has not been widely adopted because of concerns about its complexity and sturdiness.

Fig.8: Dimensions of the current design in neutral position

Fig.9: Opus loop and its dimensions
Mushroom loop\(^7\):  
Nanda has described what he calls a mushroom loop. It is quite similar to the T loop except that its apical area is curved. (Fig. 10) It can be used for individual canine retraction or for en-masse anterior retraction by incorporating adequate torque.

![Mushroom loop](Image)

Rectangular loop\(^8\):  
This is a very useful design for first and second order corrections of canines and premolars, i.e. to correct the rotations, to extrude, or to correct the root angulations. (Fig. 11) If continuous archwires are used for these corrections, the reciprocal effects, which are generally unfavorable, are felt on the immediate adjacent teeth. Such effects are minimized with the rectangular loop. Also, it can be activated in different ways.

![Canine retraction with R loop](Image)

Extra Oral Methods:  
Direct head gear retraction:  
J hook head gear is used for retracting the canine. It is four hooked for both maxillary and mandibular arches, and hooks are clipped on to archwire hooks, mesial to canine. (fig.12) Force is transmitted from headgear strap to teeth via J hooks. It is extremely conservative to anchorage and can be applied to both arches simultaneously. As a disadvantage, the force application is intermittent; hence, it is a slower method. Patient’s cooperation is required and canine tipping and anterior extrusion can occur.

![Medium pull headgear with J hooks](Image)

Other methods:

Rapid canine retraction through Distraction of Periodontal ligament

Liou and Huang in 1998, proposed a new concept of ‘distracting the periodontal ligament’ to elicit rapid canine retraction in three weeks. They coined the term ‘dental distraction’ for this procedure. At the time of first premolar extraction, the interseptal bone distal to the canine was undermined with a bone bur, grooving vertically inside the extraction socket along the buccal and lingual sides and extending obliquely towards the socket base. (Fig. 13) Then a tooth borne, custom made intraoral distraction device was placed to retract the canines into the extraction space. The process of osteogenesis in periodontal ligament during orthodontic tooth movement is similar to distraction in mid palatine suture during rapid palatal expansion. They concluded that the periodontal ligament could be distracted to elicit rapid canine retraction without complications. This innovative approach can significantly reduce orthodontic treatment time.

![Fig.13: Surgical technique for undermining interseptal bone distal to canine](image1)

Canine retraction with rare earth magnets

John Daskalogiannakis in his study tested the hypothesis that a prolonged constant force provides more effective tooth movement than an impulsive force of short duration. Parylene coated neodymium-iron-boron (Nd<sub>2</sub>Fe<sub>14</sub>P) block magnets were used in the experiment. Constant force delivery was noted by rare earth block magnets and this system did not require reactivation as loop was kept open by the magnetic force for entire experimental period.

![Fig.14: Canine retraction with rare earth block magnets](image2)

Clinical considerations in canine retraction:

Julie N Staggers and Nicholas Germance stated that in frictional mechanics of canine retraction, Cobalt-Chromium, Beta Titanium, and Nickel-Titanium wires produce more friction than Stainless Steel wires. Rectangular wires produce more friction than round wires and so do the larger wires more than smaller wires. Wires...
that have the lowest friction (small, round, stainless steel) are not necessarily the best archwires for sliding mechanics. For example, a .014" or .016" round wire can be distorted by elastic forces, causing excessive tipping and rotation of the retraction segment as well as the anchorage segment. A .018" or a .017" X .025" wire is less susceptible to distortion by the elastic.

In frictionless mechanics, the force of a retraction spring is applied by pulling the distal end through the molar tube and cinching it back. The moment is determined by the wire configuration and by the presence of pre-activation or of gable bends which produce an activation moment. In general, the more is the wire gingival to the bracket, the more favorable is the activation moment, and therefore the better is the overall M/F ratio.

Other than these, the composition of brackets also affects sliding mechanics. Ceramic brackets create more friction than stainless steel brackets. Although some orthodontists believe that narrower brackets produce less friction, the frictional force between bracket and wire depends on the force pressing the sliding surfaces together, not on the surface area of contact. Therefore, wide, double-wing brackets would be expected to produce the same amount of wire bracket friction as narrow, single-wing brackets. However, as the width of the bracket decreases, the distal root torquing moment also decreases, producing more crown tipping and thus greater friction.

**Canine retraction with removable appliances**

Canine retractors are the springs which are used to move the canine in distal direction. The various types of canine retractors are as follows:

**Palatal Canine Retractor:** The distal movement of the canine teeth can be brought about by a palatal canine retractor if the canine is palatally placed which is made out of 0.6mm stainless steel wire with a coil of 3mm diameter, an active arm and a guide arm. The helix is placed along the long axis of the canine. Activation is done by opening the helix 2mm at a time.

**The 'U' Loop Canine Retractor:** Mechanically it is least effective and used when only minimum retraction of 1-2mm is required. It is made of 0.6mm stainless steel wire. It consists of a U loop, an active arm and a retentive arm which is distal. The base of the U loop is 2-3mm below the cervical margin. It is activated by closing the U loop. The advantages of this retractor are its simplicity of fabrication and lesser bulk.

**Reverse Loop Buccal or Helical Canine Retractor:** It is used when the sulcus is shallow, as in the lower arch. Its flexibility depends on the height of the vertical loop and should be as high as possible. It is made of 0.7mm stainless steel wire. Activation is done by cutting off 1mm of wire from the free end and re-forming it to engage the mesial surface of canine. Alternatively it can be activated by opening the loop by 1mm.

**Buccal Canine Retractor:** The buccal canine retractor is used when the tooth has to be moved palatally and distally. It is made of 0.7mm stainless steel wire to provide sufficient strength. It should not be activated by more than 1mm because it is stiff and force decays rapidly as the tooth moves which results in difficulty to maintain continuous tooth movement.

**Supported Buccal Retractor:** It is made of 0.5mm stainless steel wire supported in a tubing of 0.5mm internal diameter. It is more than twice as flexible as the standard canine retractor, the tubing imparts excellent stability.

**Conclusion:** Depending upon the condition and severity of malocclusion and treatment techniques employed, a number of methods are used for the retraction of canine either by fixed or removable orthodontic appliances. No single technique suits every situation because each technique has its limitation. Thus the individual clinician must choose the method

preference to treat malocclusion which requires tipping or bodily movement or rotation of teeth with minimal time, to produce an aesthetic and functional and near ideal occlusion as much as possible.

References: