Overview of Different Methods of Canine Retraction

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Abstract

Space closure in Orthodontic patients who have undergone first premolar extraction can be accomplished in one stage that is en-masse retraction or in two stages that is first retracting the canines followed by retraction of four incisors using sliding or loop mechanics. This article gives a comprehensive overview of different methods of canine retraction at one place.

Introduction

Orthodontic tooth movement is a unique process by which a tooth is made to move through bone by the application of an appropriate force. Space closure in Orthodontic patients who have undergone first premolar extraction can either be accomplished in one stage that is en-masse retraction, or in two stages, that is first retracting the canines followed by retraction of four incisors using sliding or loop mechanics. The en-masse retraction of anterior teeth accomplishes faster space closure but is more taxing on the anchorage. Though there is an unsightly appearance of space between the lateral incisor and canine in two stage retraction and time taken to accomplish space closure is more, but, anchorage is less taxed[1].

Any method of force application for canine retraction would be considered effective as long as it is able to overcome the force of friction between the archwire and the bracket and at the same time give maximum rate of tooth movement with limited side effects. In sliding mechanics, the canine, through application of a force is expected to slide distally along a continuous arch wire, whereas in the frictionless system the tooth moves with the wire and more continuous type of tooth movement is seen by eleminating intermittent "stick-slip" force delivery seen in sliding mechanics. The force system is generated into the loop by altering the position of the loop or by altering angulations on the mesial (alpha bend) and distal (beta bend) legs of the loop. This mechanics generates desirable M/F ratio needed for bodily retraction of canine[2,3].

Several methods of canine retraction are reported in the literature. This article gives a comprehensive overview of different methods of canine retraction at one place.

Methods of Canine Retraction

1) Canine retraction using sliding mechanics: It is accomplished by using different force delivery system from canine hook to the anchorage units.

A. Elastomeric auxiliaries: There are two types of elastomers used in orthodontics natural elastomers, ie "elastics" and synthetic elastomers ie alastiks like elastomeric chains, ligatures, or elastic threads made from polyurethanes (thermoplastic or thermoset).

Thermoplastic materials can be made from plastic and are moldable at high temperatures, while thermoset materials are irreversibly cured during the process of manufacturing, are not remoldable, and will burn at high temperatures[4,5].

I. Elastics: Class I or Class II elastic can be used for canine retraction if canine roots have distal angulation. Class II elastics are taxing on maxillary molars whereas Class II elastics can be used be in cases where lower molars have to be brought forward in Class II molar relationship. The major disadvantage is patient compliance in wearing the elastic[4,5.] Canine retraction by Class II elastics had a disadvantage of its distal tipping in Begg's technique that was eliminated in Kemada's technique, using safety T pin in Kemada's bracket with torque, to prevent mesiodistal tipping of the tooth along with labiolingual control of that tooth.

II. Elastic chains: Since 1960 Orthodontic elastomeric chains are being used for canine retraction as they are economical. One of the biggest shortcomings of elastomers is the rapid decay of force over time and hence are replaced at 3 to 4week intervals. The effect of initial force on force decay is debatable and prestretching elastomeric chains before using them does not seem to produce a meaningful difference.[4-6] Masoud et concluded TS (thermoset) chains decayed less than thermoplastic (TP) chains. Balhoff et al reported that the direct chain designs had less force decay compared to the chain loop design. (Figure 1).

III. Elastic threads: were used initially but had a drawback of not being able to predict its force values.

IV. Elastic modules/ active tie back: This method of retraction had been popularized by Bennett and Mclaughlin. A prestretched single elastic module extending from the molar is attached to the canine by ligature wires on 0.019" x .025"SS wires. These elastic tiebacks are stretched twice their original size to generate approximately 50-100 gm of force and are replaced every four to six weeks. MBT technique advised retraction of canine from first day using stainless steel laceback ligatures[4,5]. Sueri etal found that the maxillary canine moved effectively in sagittal, vertical and transverse planes whereas the molar movement was less. (Figure 2).

B. Stainless steel and NiTi coil spring: Considering the major drawback of rapid force decay in elastomeric auxiliaries, metallic closed coil spring was used for retraction of canine. 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. Coil spring made of Stainless steel with high load deflection rate exerted large forces initially causing delayed tooth movement followed by rapid movement and then slowed down the process because of force decay, whereas NiTi closed coil spring had low load deflection rate and produced continuous and effective tooth movement without causing patient discomfort.[4-6] Samuels and Rudge found that NiTi coil springs produce more consistent space closure than elastics. They are available in 2 sizes 9mm and 12 mm (springs should not be extended more than 22mm for 9mm spring and 36mm for 12 mm spring. They delivered constant force till the terminal end of deactivation stage is reached. Tripolt et al found that heavy, medium, and light Ni-Ti closed coil produced a relatively constant force for longer duration. Deguchi et al concluded that the retraction with NiTi coil spring had shorter duration and 50 grams of forces was effective for canine retraction at times open coil spring can be used to move canine diatally especially in cases of crowding or blocked out lateral incisors.. (Figure 3).

2) Canine retraction using loop mechanics

A. T loop: Burstone T-Loop Retraction Spring was first introduced by Charles H. Burstone at the University of Connecticut in 1982[7]. It can be fabricated from 0.017" × 0.025" inch TMA or 0.16" × 0.022" inch SS wires. It was specially designed for canine retraction in segmented arch technique. It had a horizontal loop of 10 mm length and was 2 mm high. The spring is made passive from auxiliary tube of molars to cuspid with height of mesial leg being 5 mm and distal leg being 4 mm. There is six point preactivation of T-Loop with each of 30°, making a total of 180° activation. The preactivation bends are actually overbent so that after the trial activation, about 180° of moment preactivation is left. Anti rotation bends of 120° is given in mesial leg of the loop to prevent distal in and mesial out rotational tendency of the canine. T-loop is activated horizontally by 4 mm[8-10]. The neutral position of this canine retraction spring is 2 mm. (Figure 4).

T loop position: For equal movement of the canine and the buccal segment, the pre-activated T-loop should be positioned equidistant between the molar and the cuspid bracket. . A standard shaped T-loop can be used for differential anchorage requirements by altering mesial-distal position of the spring that produces differential moments. More posterior positioning produces an increased beta moment whereas more anterior positioning produces an increased alpha moment. (Figure 5).

B. Ricketts retraction spring: It is a double vertical helical extended crossed T closing loop spring made of 0.016" × 0.022" SS wire that can be activated by 3-4mm at a time. It produces a force of 50 gm/1mm of activation[11]. (Figure 6).

C. PG retraction spring- It was introduced by Poul Gjessing of Denmark in 1985. It is made of 0.016 × 0.022 inch SS wire with double ovoid helix 10 mm high, placed gingivally to reduce the load deflection of the spring and cause tipping of the short arm. A smaller helix of 2 mm diameter placed occlusally, lower the level of activation on insertion and is formed so that activation further closes the loop. It produces 160 gm of force/ 1 mm of activation[11,-13].

Pre-activation bends of 15° and 12° were placed on the anterior and posterior legs, respectively with an anti rotation bend of 30° in the distal extension. Spring can be adjusted for canine retraction, uprighting of canine or incisor Retraction. (Figure 7).

D. Bull loop: Dr. Harry Bull's designed the Bull loop with 0.021" X 0.025" steel wire. For maxillary cuspid, it is 7 mm high with 18mm of wire distal and 22 mm of wire mesial to the loop. For mandibular arch, it is 5 mm in height with 20mm of wire distal and 28 mm of wire mesial to the loop. The loop is held between the parallel beak-closing plier and the vertical arm is bent toward the horizontal to place a gingival bend of 45° to 60° in the cuspid arm to obtain a lighter force with greater deflection, thus bringing the cuspid back bodily[14]. (Figure 8).

E. Mushroom loop: Mushroom loop for canine retraction was described by Nanda. It is quite similar to the T loop except that its apical area is curved. It can be used for individual canine retraction or for en-masse anterior retraction by incorporating adequate torque. The M-Loop produces lower and more continuous forces compared to simpler designs due to apical addition of the wire in the archival configuration which decreases the load-deflection rate. Additionally, the archival shape has the added advantage of increasing the applied moment when the spring is activated. The decreased force and increased moment, when activated, increases the M/F ratio and allows for greater root control and anchorage. Moreover the CNA beta-titanium recommended for use in the M-loop has a much lower stiffness than stainless steel and promotes a more constant force delivery[15].

Wire dimensions are 0.017" X 0.025" CNA, although, for adults requiring lower force values, 0.016" X 0.022" may be preferred. (Figure 9).

F. Remaloy cuspid retraction spring: This preformed spring made of 0.016×0.022" Blue Elgiloy wire was introduced by Ladanyi as a modification of closed helical vertical loop. The spring design was said to deliver 90 gm of force/mm of activation. The spring was gentle, long acting, produced bodily retraction of canine. In a study by Elrifai et al, upper canines retracted significantly at a rate of 2 ± 0.17mm/month.. However, the canine tipping and rotation need to be decreased by increasing the antitipping and antirotation angles or by decreasing the force used for canine retraction[16]. (Figure 10).

3) Other methods of Canine retraction

A. Temporary Anchorage Devices / TAD: In absolute anchorage cases for canine retraction, miniscrews are placed buccally between the roots of the permanent first molar and the second premolar. Canine retraction is accomplished on 0.017×0.025" SS wire by using nickel titanium springs stretched from the implant head to the hook of the canine bracket. Herman et al conducted a study on implants and found the rate of canine retraction to be 0.61 to 1.5 mm per month and concluded that Ortho implants provide adequate amount of anchorage for maxillary canine retraction without anchorage loss. (Figure 11).

B. Magnets: John Daskalogiannakis found that a prolonged constant force exerted by rare earth magnets (neodymium-iron-boron) provided more effective tooth movement than an impulsive force of short duration. The retraction assembly consisted of vertical loop of 17×25 TMA wire with a helix between second premolar and molar to receive a middle magnet, another vestibular wire of 0.018×0.025” SS is inserted in auxillary tube of molars which houses two magnets mesial and distal to the middle magnet. The mesial and middle magnets were in repelling more whereas distal and middle were in attractive mode. 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 during canine retraction[17]. (Figure 12).

C. Rapid canine retraction:

1) With distractor device: In 1998, Liou and Huang demonstrated the rapid canine retraction (RCR) of 6.5 mm by distraction of the periodontal ligament, (RCR) is well suited for the clinical situations like severe crowding[18,19], Class II Division 1 malocclusions, bialveolar protrusion, short & malformed canine roots or in patients presenting with periodontal problems. There is significant reduction in total treatment time by 6 to 9 months. After first premolar extraction, vertical osteotomies were carried out at the buccal and lingual sites of the interseptal bone adjacent to the canine tooth. The vertical osteotomies were connected with an oblique osteotomy extending toward the base of the interseptal bone to weaken the resistance. The distractors were cemented in place after the surgery[18].

A semirigid tooth-borne canine distractor designed by Dr Bengi had conventional palatal tubes soldered on the buccal surface of the molar and canine bands, perpendicular to each other. The device consisted of an anterior section, a posterior section, a screw, and a hex wrench to advance the screw. The posterior section included a round sliding rod (1.5 mm), a retention arm (with a rectangular tip) for the first molar tube, and a grooved screw socket. The anterior section included a retention arm (with rectangular tip) for the canine tube and two non-grooved slots for the sliding rod and screw. The screw (2.5 mm) and the hex wrench were produced in a military establishment and fabricated from stainless steel. The distractor was unilateral, a 360 degree activation of the screw produced 0.5 mm of distal movement in the canine tooth. The length of the screw was arranged according to the distance between the distal point of the canine and the mesial point of the first molar[20-21] (Figure 13). Sayın[18] found that the maxillary canines were distalized by 5.76 mm with 11.478° distal tipping using periodontal distractor.

2) Without distractor device:

There are three options to shorten the time of treatment:

(i) Local administration of chemical substances- PGE, cytokines that include lymphocytes & monocyte derived factors, receptors activator of nuclear factors Kappa β ligand (RANKL), and macrophage colony stimulating factors (MCSF) can be used to get rapid tooth movement[22].

(ii) Physical stimulants including direct electric currents, pulsed electromagnetic field, static magnetic field, resonance vibration and low level lasers which enhances the rate of canine retraction. (i.e., electrical current or LUPUS)[22],

(iii) Surgery/ Surgically Assisted:

A) Corticotomy-assisted orthodontic treatment ie. CAOT involves making cuts, grooves in bone distal to canine and applying distal force with any retraction mechanics .It provide an increased net alveolar volume after orthodontic treatment.

B) The technique of Wilckodontics[19-20] (Periodontally accelerated osteogenic orthodontics (PAOO)) involves the removal of a portion of cortical bone just enough to initiate a local response known as the Regional acceleratory phenomenon (RAP) and should not create movable alveolar segments. This technique is a combination of a selective decortications facilitated orthodontic technique and alveolar augmentation. This procedure has several advantages, such as, reduced treatment time, enhanced expansion, differential tooth movement, increased traction of impacted teeth and an increased post orthodontic stability. With the help of this technique teeth can be moved 2 to 3 times faster in 1/3rd to 1/4th the time required for traditional orthodontic therapy[22] (Figure 14).

C) Piezoincision is a promising tooth acceleration technique because of its various advantages on the periodontal, aesthetics and orthodontics aspects. Technique involves primary incision placed on the buccal gingiva by piezo surgical knife followed by incisors to the buccal cortex. This technique can be used with invisalign which leads to better aesthetic appearance and less treatment time as reported by Keser et al[23].

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 in minimal time, to produce an aesthetic and functional and near ideal occlusion as much as possible.

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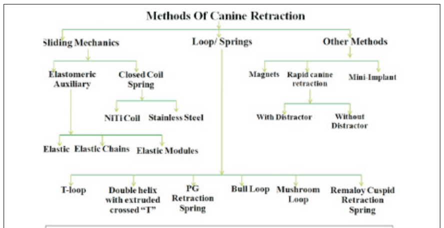
Figures of Legands



Schematic diagram showing various methods of canine retraction

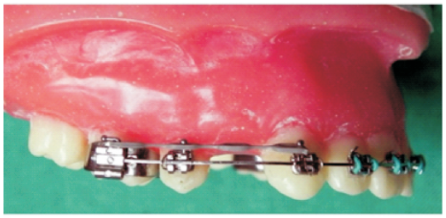


Figure 1: Canine retraction by Elastic Chains

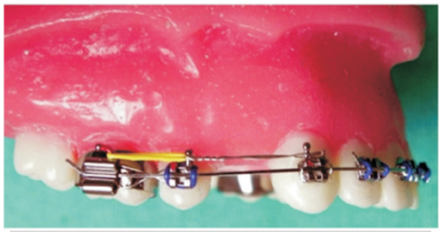


Figure 2: Canine retraction by Elastic modules/ Active tie back

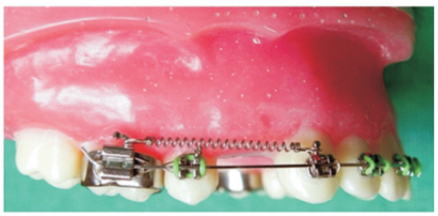


Figure 3: Canine retraction Closed Coil Spring

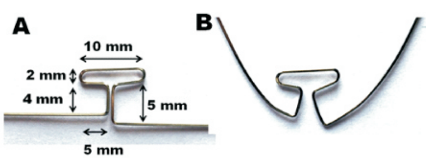


Figure 4 A: Standard form and dimension of T-Loop described by Burstone. B: T-Loop with preactivation bends`

Figure 5: Canine retraction by T-Loop

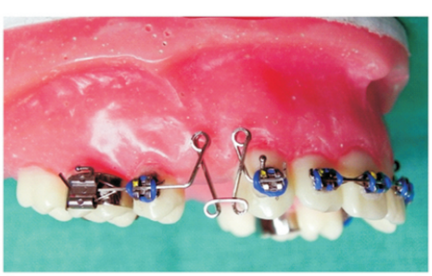


Figure 6: Canine retraction by Double helix with extruded crossed "T" (by Ricketts)

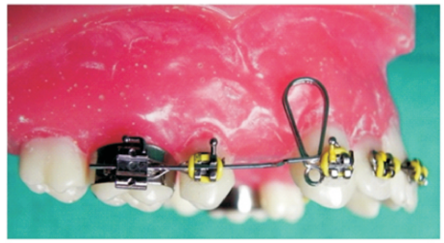


Figure 7: Canine retraction by PG Retraction Spring.

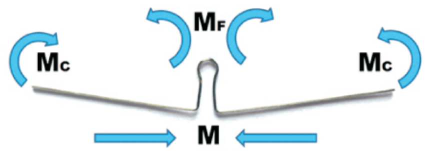


Figure 8: Canine retraction by Bull Loop

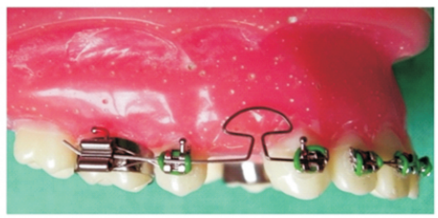


Figure 9: Canine retraction by Mushroom Loop

Figure 10: Canine retraction by Remaloy Cuspid Retraction Spring

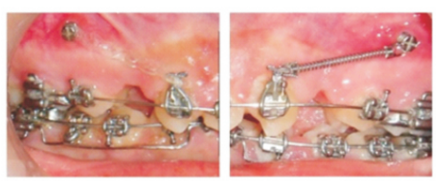


Figure 11: Temporary anchorage devices used for canine retraction.

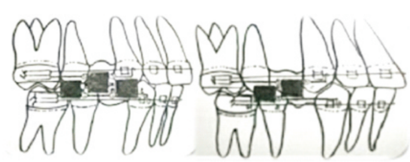


Figure 12: Constant force delivery by rare earth magnets

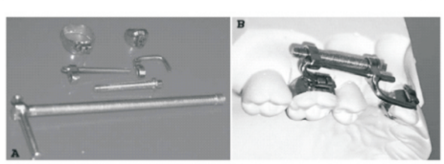


Figure 13: Periodontal Distractor Devices: (A) Component and (B) Individual Canine Distractor

Figure 14: Wilcodontics involves Selective Decortication Facilitated Orthodontic Technique to initiate Regional Acceleratory Phenomenon (RAP)