Review Article

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Loops: Application in Orthodontics

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ABSTRACT

Background: Loops are an effective means of controlling orthodontic forces. Their origin can be traced back to the year 1915 when R.D. Robinson first mentioned them in an article titled “A system of positive and painless tooth movement”. R.H. Strang, in the year 1933, introduced them into the Edgewise system for retraction of teeth. However, loops have various applications in the course of orthodontic treatment. Some of them include mesial or distal movement, space closure, space opening, bite opening, root tipping or paralleling, axial inclination correction, etc. The aim of this paper is to review the literature for different loop designs, biomechanics, indications, mode of activation, advantages and disadvantages, comparisons within various types of loops, and their clinical utility which will help clinicians to select and use a particular loop design to get effective treatment results.

Keywords: Loop, orthodontics, dentistry.

INTRODUCTION

Optimum control of tooth movement requires the application of specific orthodontic force systems, which can be achieved by the precise application of different types of loops.[1] Loops were introduced in orthodontics by R.D. Robinson in 1915. Since then many orthodontists have successfully used loops in various orthodontic treatment mechanics.[2]

A few of the common applications of the loops in orthodontic treatment are: mesial or distal movement, space closure, space opening, bite opening, root tipping, correction of axial inclination, leveling and rotating, intrusion, alignment of second molar, extrusion and labial tipping etc.[1]

FRICTIONLESS MECHANICS

- Space closure with loops is accomplished by frictionless mechanics also known as "segmental mechanics", where the teeth move without the brackets sliding along the archwire. It offers more controlled tooth movement than sliding mechanics. The segmented arch technique was developed by Burstone, in early 1960‘s.[3]

Rationale of the segmented arch [4]

- Constant moment-to-force ratio over a long range of activation.
- The resultant motion of teeth about a predictable center of rotation
- The controlled force system at anchor teeth.

Rationale behind the segmentation of the arch

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- Consolidation of teeth into units, to achieve proper intra-segmental tooth to tooth relationship.
- Use of varying cross section of the arch wire at different location in the same arch.
- Increasing inter-attachment distance and force distribution around the arch.
- Prefabrication and pre-calibration of active components.
- Increasing clinical efficiency.

Advantages of segmentation:

- The force systems at the active and reactive units are relatively constant and defined
- Wires with variable stiffness can be used in the same arch
- It allows a choice of either posterior extrusion, true anterior intrusion or a combination
- Frictional forces are eliminated.

LOOP DESIGN [5]

- Frictionless mechanics have evolved from simple vertical to present more complex loop design. The physical properties of loop is related to two entities – Load and Deformation

- Similar to an archwire, the deformation of a loop is elastic initially i.e. it can completely return to its original form when external load is removed.

- The orthodontic loop should have:

    1. A large range of activation
    2. A large allowable working load
    3. A low load deflection rate.

- The important criteria to be considered for the use of closing loops are given as follows.

1. **Loop position -** A centred loop produces equal and opposite moments with negligible vertical forces. Off-centre positioning of a loop produces differential moments. Asymmetric positioning of the loop produce differential moments. The magnitude of moment is greatest at the teeth nearest to the loop and smallest at the distant teeth.

2. **Loop pre-activation -**The moments occurring through activation alone are insufficient to produce an adequate force system necessary for root control. Thus, gable bends are given to increase the root control, avoiding 'dumping' of teeth into the extraction space. Therefore desired alpha and beta moments are placed anterior and posterior to loop vertical legs.

3. **Loop design -**Ideal loop design should meet certain criteria most notably a large activation, low and constant force delivery with low load deflection rate and comfortable for patient.

Burstone T loop attraction spring [6]

The T loop space closure springs is used for separate canine retraction or en masse retraction of all 6 anterior teeth. T-loop is of two types: Composite and Symmetrical. T loop is fabricated using 0.017 x 0.025 TMA wire. Before the placement of T- spring in mouth there is six point preactivation of loop, making a total of 180° activation in the loop from its neutral position shape followed by trial activation. T loop generates relatively high horizontal forces of approximately 350 gm.[3]

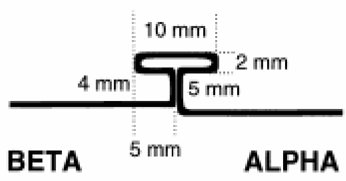

Fig.1 Burstone T loop

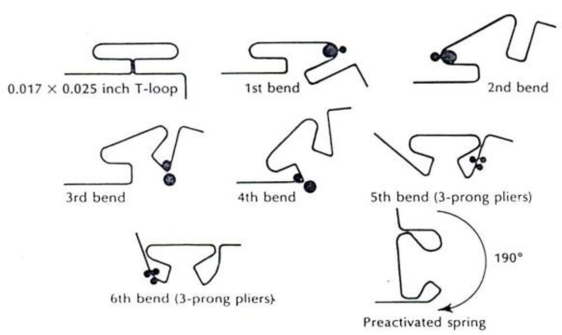

Fig. 2 Activation of T-loop

The Asymmetric T loop [7]

James J. Hilgers and **Dr. Farrokh Farzin-Nia in 1992** introduced the Asymmetric T loop made from 0.016" x 0.022" TMA (for 0.018" brackets) or 0.019" x 0.025" TMA (for .022" brackets) for the purpose of intrusion of the incisors simultaneous with anterior space closure, using a continuous archwire. Preactivation of loop is done by compressing the short mesial loop & opening the long distal loop to create a step between anterior and posterior segments that allows simultaneous bite opening and anterior space closure. The loop can be activated intraorally to advance the upper incisors during the initial phase of treatment, or to increase torque during retraction.

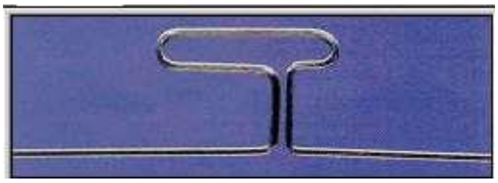

Fig. 3 Asymmetric T loop

Vertical loops [8]

DR. R. H. W. STRANG introduced vertical loops into the edgewise appliance during **Early 1930's.** It is one of the most commonly used loop for retraction mechanics fabricated from 0.016" stainless steel wire. It can be open or closed. A helix can be incorporated at the apex of the loop to decrease the load deflection rate and allow for larger activation and increases the M/F ratio than that of the standard vertical loop. To increase the level of moments produced, the spring can be preactivated, by addition of gable bends. Closed loop when activated by compression tend to shorten the arch length whereas open loop upon ativation by compression **t**end to increase the arch length.

Types of Vertical loop

- Single open vertical loop
- Single closed vertical loop
- Double vertical loop
- Twin helical loop

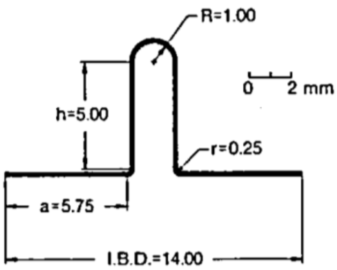

Fig 4: Vertical Loop

Horizontal Loops [9]

- In 1960, STONER introduced a horizontal loop, formed in such a manner that its active legs were parallel to the archwire, to effect force reduction in the occlusogingival direction. These can be open or closed. These loops enhance the reduction of forces in the occlusogingival direction. It is effective when it is necessary to open the bite or to elevate or depress the anterior or posterior segment. As with any loop, the most efficient range of activity is obtained when the legs of horizontal loop are compressed. So to make certain that legs are compressed, contour of the loop is such that its legs overly the shorter tooth.

Modifications of the horizontal loop

Horizontal T loop

Double horizontal loop

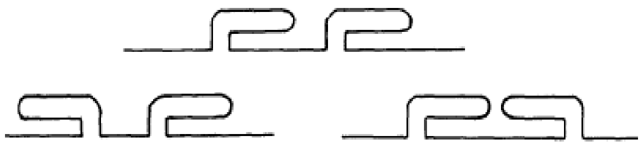

Fig 5: Horizontal loop

Omega Loop [9]

- It is a variation of open vertical loop given by **Dr Morris Stoner in 1960.** It is shaped like a Greek letter "Ω" and hence the name. It tends to distribute stresses more evenly instead of concentrating them at apex. It is used to apply moment to the last tooth in arch causing bodily root thrust.

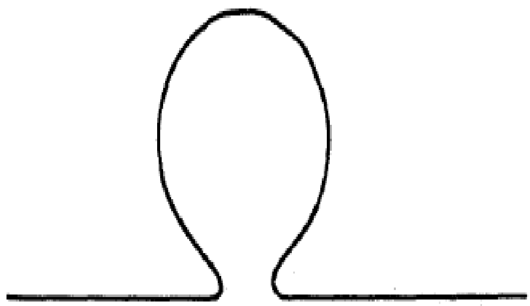

Fig. 6 Omega loop

Double keyhole loop [10]

- John Parker introduced this loop and used it in second phase of Roth's treatment mechanics. The loop archwire is 0.019 x 0.025 in dimension, bent out of round edge rectangular wire. The anterior teeth are retracted en masse as a group of 6. The double keyhole loop archwire allows complete space closure with one set of archwires. In addition, the double keyhole loops controls the canine rotation during the extraction site closure.

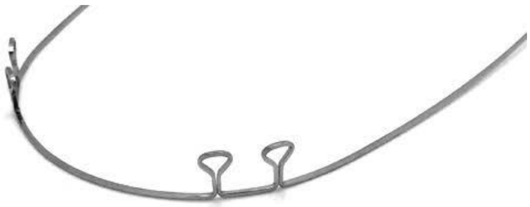

Fig 7: Double keyhole loop

Box Loop [11]

The box loop generate well defined orthodontic forces that lead to highly controlled tooth movement to correct the positional discrepancies of single tooth. It is fabricated by giving vertical and horizontal lever bend in a single 0.014" or .016" or .018" x 0.025" stainless steel wire, contoured to the width of single tooth, so as to provide a short section of the arch wire freely movable in all three planes of space. On activation, the loop distorts from its original configuration, gradually returns to its undistorted position as the tooth movement occurs.

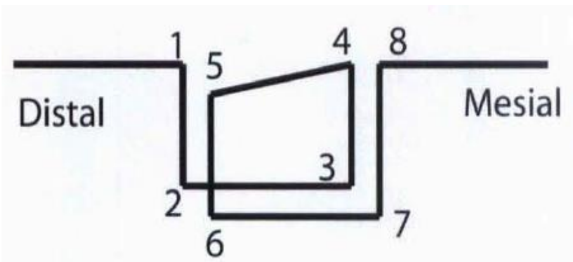

Fig 8: Box loop

Bull Loop [12]

Introduced by **Harry L. Bull** in **1951,** the loop is fabricated with 0.021" X 0.025" steel wire. The loop is used to retract canine bodily by means of sectional arch. For upper canine retraction sectional arch, the height of loop is approximately 7 mm and for lower sectional, the loop is 5 mm in height. The loop is activated by holding the loop 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.

Fig 9: Mushroom loop.

MUSHROOM LOOP / M LOOP [13]

This loop developed by **Dr. Ravindra Nanda,** is a modification of T-loop.

The preformed mushroom-loop space-closing archwire produces an ideal moment-to-force ratio for translator movement during retraction of anterior segment. Wire dimensions are 0.017" x 0.025" CNA, although, for adults requiring lower force values 0.016" x 0.022" may be preferred. The archwire is preactivated outside the mouth to achieve the proper moment-to-force ratio. Additional gable bends may be placed mesial and distal to mushroom loop to increase the anterior moment (torque) and the anchorage moment respectively.

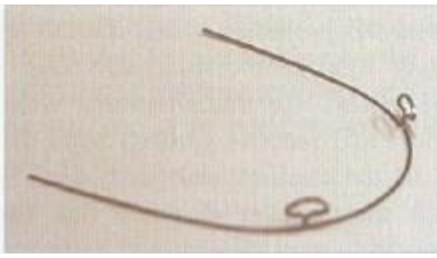

Fig 11: Mushroom loop

NiTi Canine Retraction Spring [14]

YASOO WATANABE and **KEISUKE MIYAMOTO** in 2002 designed this spring to retract canine into extraction site without tipping and rotation. The spring design has a simple vertical closing loop with antitip and antirotation bends incorporated by heat-treating the 0.016" × 0.022" NiTi wire in an electric oven. Height of the spring 10mm. The major advantage of this spring is the ability to use it without a preliminary leveling stage, because it can simultaneously retract the canines and level the posterior teeth.

Fig 12: NiTi Canine retraction spring

RECTANGULAR LOOP/ R-LOOP [15]

Vittorio Cacciafesta and Berte Melsen in 1999 introduced R Loop for the correction of specific irregularities in all three planes of space. The loop can be used for first, second and third order corrections. Because of its insertion in at least in two brackets; it represents a statically indeterminate system.

It can be activated to release any force and moment ratio at the anterior bracket: a pure force, a pure moment or any other combination. The desired combination of moments and forces can be reached by choosing different points of force application, controlling the horizontal dimension of the loop or by angulating the horizontal branch of the loop with respect to the bracket of the active unit.

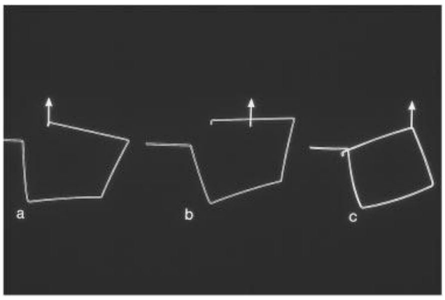

Fig 13: Rectangular loop

The Snail Loop [16]

This loop was designed by **Dr. Pawankumar J. Vibhute in 2008,** for en masse space closure of anterior teeth with a potential for greater, more efficient vertical movement of the anterior segment, due to the flexibility in the vertical plane provided by the spiral design. The loop is fabricated from 0.017"x 0.025" stainless steel wire by bending a simple omega loop into a spiral shape. The loop is 8mm high and 6mm wide. The loop can be activated twice as much as, omega loop before undergoing permanent deformation. The anterior and posterior moments produced by the preactivation bends counteract the tipping moments created by the retraction force of the appliance, and are reinforced by the activation moment produced by the loop's spiral design. Miniscrews may be used with the snail loop for additional anchorage.

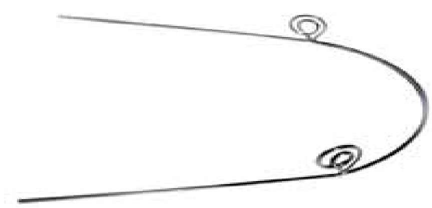

Fig 15: Snail loop

Teardrop Loop [17]

This loop was used by **R.G. ALEXANDER** in **1983,** in his **Vari-simplex discipline** for retraction of four incisors in maxillary and en masse retraction in mandibular arch. It is similar to the omega loop with height of approximately 5 mm. wire used for fabrication is 0.018× 0.025 SS for maxillary arch and 0.016× 0.022 SS for mandibular arch. Before placing the archwire in the mouth, the portion of the archwire distal to the closing loops is reduced approximately 0.001" in the anodic polisher, so that part of the wire can slide through the brackets easily during activation. The closing loop should be activated by 1 mm per appointment. If the loop is activated by a larger amount, tipping and bite closure are more likely to occur as the four incisors are retracted.

Fig 16: Teardrop Loop

The Wave Spring [18]

Introduced by **WILLIAM VOGT** in **2004, t**he Wave Spring is a orthodontic retraction spring that takes the shape of a wave when extended. Constructed from superelastic NiTi alloy, the spring delivers a relatively large amount of activation about 90g of force despite its compact size. The spring returns to its original shape even when activated to more than three times its resting length, without permanent deformation.

The Wave Spring's greatest attribute is its ability to fit into a small space yet remain active over a long distance. Because it has no coils, it excels in the extrusion of impacted teeth, using either an open or a closed technique.

Fig 17: Wave spring

Bernstein's bite opening and space closing archwire [19]

Introduced by **Leonard Bernstein** in **1970** to provide an upward and backward force in an arc shaped motion to the maxillary central and lateral incisors with a retraction force at the same time. The size of the wire used was 0.016 X 0.022gauge. The design of archwire incorporates a 2-3 mm helix bent immediately distal to the lateral incisors with closing loops superimposed on these helices on the buccal aspect. This archwire has a advantage that by keeping a distal closing force on teeth, the upward and backward force produces bite opening.

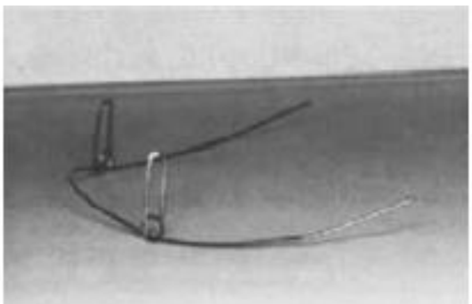

Fig 19: Bernstein's space closure archwire

PG retraction spring [20]

Introduced by Poul Gjessing in 1985, spring was designed for canine retraction. In 1992 Gjessing adopted it for en-mass retraction of four incisors. It is fabricated using 0.016"x.022" stainless steel wire. The spring has gingivally directed overlapping double helices, ovoid in shape, 10mm in height and 5.5mm at its widest part, with a small occlusal helix 2mm in diameter. The basic element of the system is available in right and left versions. The PG retraction system, facilitate segmented treatment of extraction cases. It is a prefabricated, highly standardized, stainless steel retraction spring that is adjustable to fit both .018" and .022" edgewise appliances. The design of spring, allow for controlled retraction of either canines or upper incisors and rigid stainless steel wire, lends good stability to this spring. The spring is precalibrated to deliver predictable moment-to-force ratios in three planes of space.

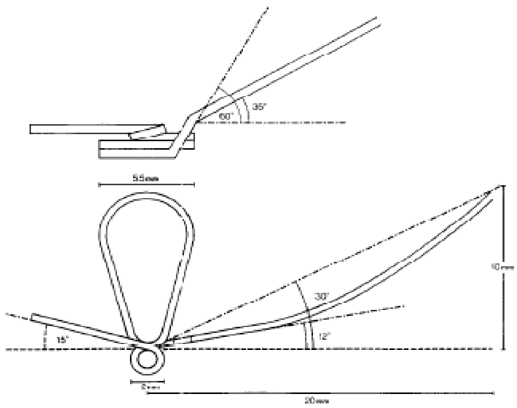

Fig 20: Pg retraction spring

CONCLUSION

Frictionless mechanics with the incorporation of loops at various stages of orthodontic treatment especially during space closure has made orthodontic treatment more comfortable to patients as well as clinicians. Loops have been advocated for a number of reasons such as improved resiliency of an appliance, significant reduction in the number of clinical adjustments. One of the major advantages is that a known force system is delivered to teeth. The application of differential moments between teeth is recognised as an effective means for achieving desired tooth movement and anchorage control, which is possible with the use of various loops. Loop systems when used with a full understanding of their reciprocal effects, offer positive advantages in correcting selected cases of malocclusion. Judicial use of this knowledge will serve the operator to carefully select an appropriate loop mechanics for particular clinical situation and obtain better and comfortable treatment result with less patient appointments without sacrificing the quality of orthodontic treatment.

CONFLICTS OF INTEREST

The authors declare they have no potential conflict of interests regarding this article.

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