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"A" Loop : A New Loop for Management of Impacted or Ectopically Erupted Canines

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Abstract

The ectopic eruption and impaction of permanent canine is a common problem encountered in clinical practice. As maxillary canine is the last permanent tooth to erupt (except third molars), it is most prevalent to be malpositioned or remain impacted due to tooth size arch length discrepancy. The orthodontic treatment of impacted maxillary canine remains a challenge to today's clinicians. The treatment of this clinical entity usually involves surgical exposure of the impacted tooth, followed by orthodontic traction to guide and align it into the dental arch so that it comes into occlusion. Auxiliary springs have been used in orthodontics since long for correction of impacted/unerupted canines or adjacent teeth. Cantilever springs are preferred than the continuous wires as placement of continuous flexible wires for correction of these single tooth malocclusions produces an adverse effect on adjacent teeth. A common disadvantage in all of the loops and techniques mentioned above is that it offers a poor anchorage control in extraction cases. Usually the root of impacted canines is near the cortical bone and needs to be brought into cancellous bone, so as to prevent the resorption and also faster movement of the canine. Keeping these points in mind we designed a loop, which fulfills most of the shortcomings, which are discussed above. This loops is called "A loop" as its shape resembles the shape of alphabet "A". The design, fabrication, biomechanics, advantages and disadvantages of "A loop" are discussed in this article.

Keywords: A loop, Ectopically Erupted Canine, Frictionless Mechanics, Impacted Canine, Individual Canine Retraction, Loop Mechanics, Torque Control on Canine

1. Introduction

The ectopic eruption and impaction of permanent canine is a common problem encountered in clinical practice. The highest incidence of impacted canines 7.9% was reported in literature among Iceland population[1]. In Americans[2,3] and Israeli[4] it is found to be 1.5%. Lowest incidence of impacted canines is seen in Japanese sample population[5]. As maxillary canine is the last permanent tooth to erupt (except third molars), it is most prevalent to be malpositioned or remain impacted due to tooth size arch length discrepancy. The impaction of mandibular canines is less frequent and is reported to be 20 times less as compared to maxillary canines[6]. Majority of canine impactions are palatal 85% and only 15% are labial[7]. Unilateral impactions are more common as compared to bilateral[8].

The orthodontic treatment of impacted maxillary canine remains a challenge to today's clinicians. The treatment of this clinical entity usually involves surgical exposure of the impacted tooth, followed by orthodontic traction to guide and align it into the dental arch so that it comes into occlusion. Bone loss, root resorption and gingival recession around the treated teeth are some of the

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Table 1. Summary of Orthodontic techniques used to manage impacted canines.

Study	Year	Orthodontic technique
Harry Jacobay[10]	1979	Ballista Spring
Criscini et al[11]	1994	Tunnel traction
Ali Darendeliler[12,13]	1994	Magnets
Becker et al[14]	1995	Stainless steel arch wire axillary
Lindauer and Issacson[15]	1995	Cantilever Spring
Lindauer and Issacson[16]	1995	TMA box loop
Varun Kalra[17]	2000	The K-9 Spring
Christine Hauser[18]	2000	Australian Helical Wire
Jay Bowman[19]	2002	The Monkey hook
Bowman and Carano[20]	2003	The Kilroy spring, Kilroy II Spring
Dillingham and Park [21]	2004	Temporary Anchorage Device
Vibhute PKJ[22]	2011	Versatile Auxiliary Orthodontic Spring.

most common complications associated with orthodontic management of impacted canines[9].

Auxiliary springs have been used in orthodontics since long for correction of impacted/unerupted canines or adjacent teeth. Cantilever springs are preferred than the continuous wires as placement of continuous flexible wires for correction of these single tooth malocclusions produces an adverse effect on adjacent teeth. These complications include flattening of arch and open bite in that region which eventually requires more time for correction.

Various authors for management of impacted canines, a summary of which is given in Table 1, have published a number of techniques and loops.

A common disadvantage in all of the loops and techniques mentioned above is that it offers a poor anchorage control in extraction cases. Also most of the loops designed till now are in round wire so they offer a poor torque control while guiding the canine into occlusion. The torque control on the impacted canine is critical especially in palatally impacted canines. The root position of the canine is vital while its orthodontic tooth movement during retraction or guiding into occlusion as it may cause root resorption if it comes in contact with cortical bone[23].

Usually the root of impacted canines is near the cortical bone and needs to be brought into cancellous bone, so as to prevent the resorption and also faster movement of the canine. The buccal bone covering the buccally placed canine root is usually thin. Therefore, palatal root torque is needed for the canine to increase the buccal bone thickness, decrease the risk of bone dehiscence and decrease the risk of gingival recession[24]. Torque control on canine and anchorage preservation is possible with use of a loop in rectangular wire only.

Loop design, positioning and preactivation are the most important factor in determining the effectiveness of any loop[25]. An ideal loop will have high activation potential and a low load deflection rate, would be easy to fabricate and comfortable to patient[25].

Keeping these points in mind we designed a loop, which fulfills most of the shortcomings, which are discussed above. This loops is called "A loop" as its shape resembles the shape of alphabet "A". The design, fabrication, biomechanics, advantages and disadvantages of "A loop" are discussed in this article.

2. Loop Design

The A loop is fabricated in 0.017" x 0.025" TMA wire. TMA wire is used because of its mechanical properties of increased flexibility and also ease of fabrication[25]. The use of rectangular wire provides good torque control on the canine which is being moved or brought into occlusion[23]. The A loop consists of 2 helices and has control in both antero-posterior movement as well as vertical direction on the tooth being moved. Height of the loop in posterior part is 8 mm and in anterior part it is 10 mm which bent into a shape of alphabet "A" hence the name A loop, at the top of A there is a helix of 2mm diameter. The antero-posterior span of the loop is again 8 mm. the loop has one horizontal arm of 10 mm with a helix, which is 2 mm in diameter.

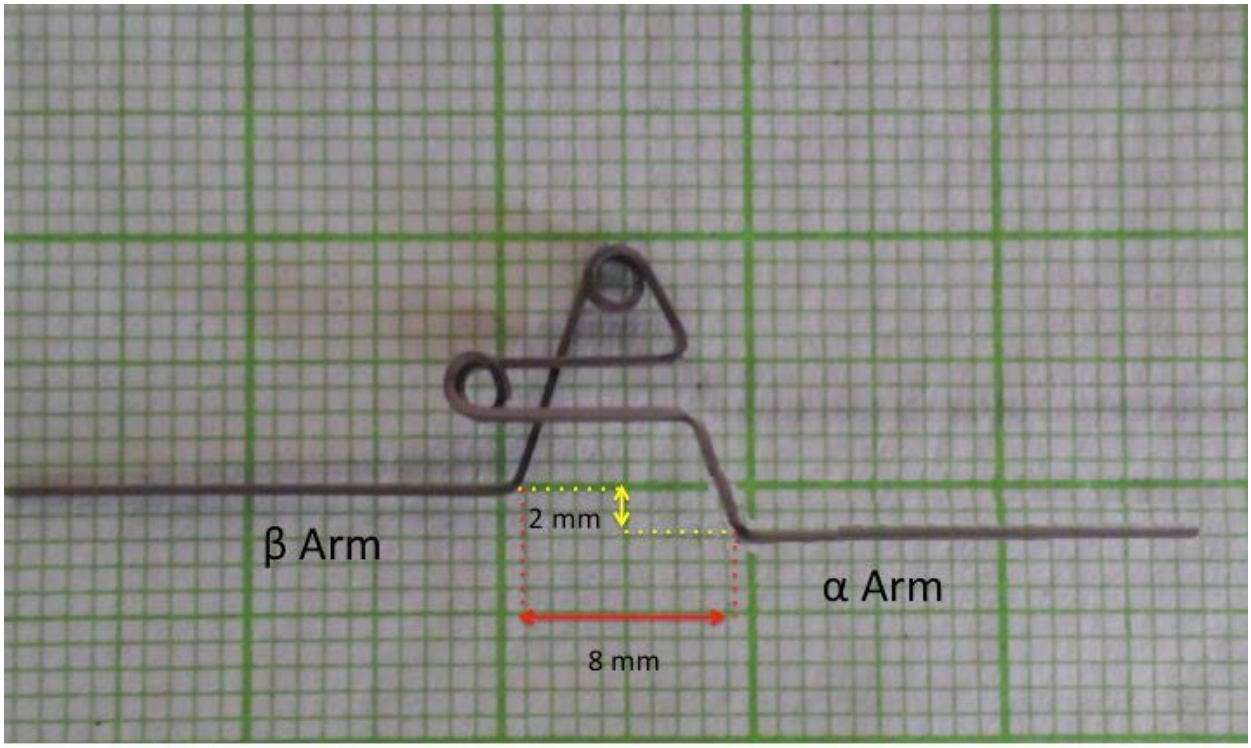


Figure 1(a). Alpha and beta arms of A loop.

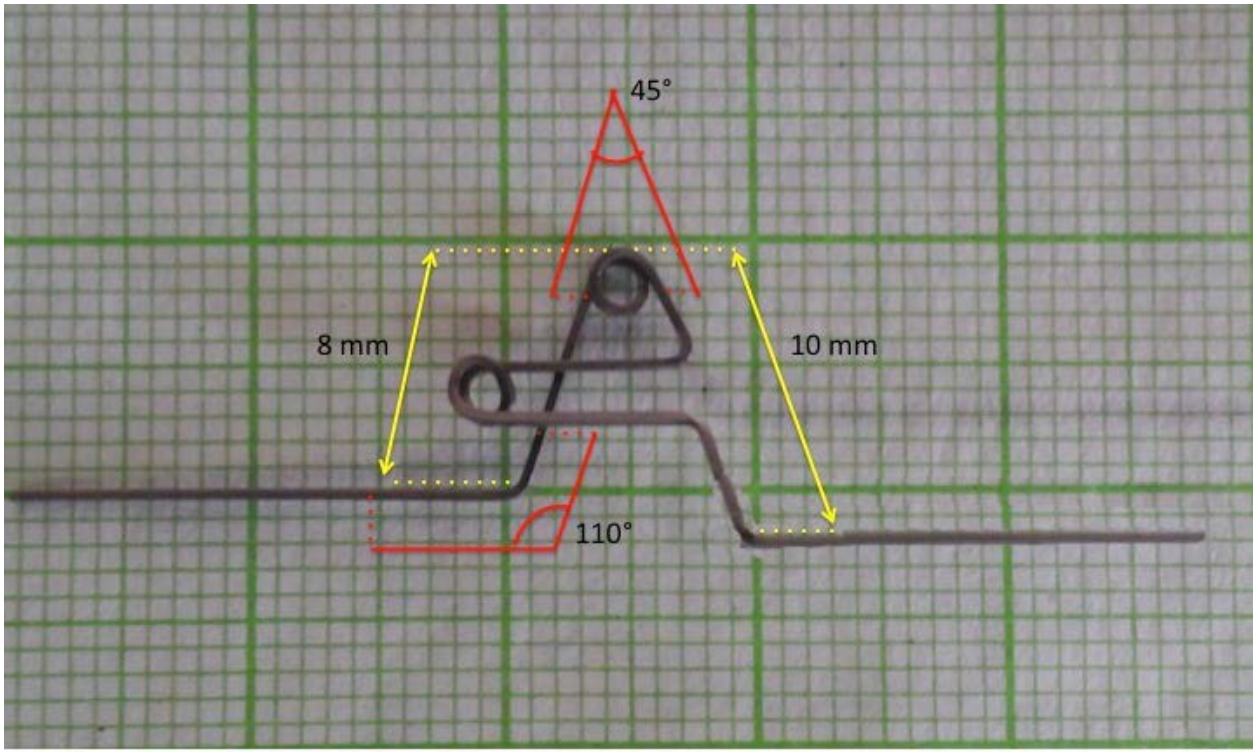


Figure 1(b). A loop vertical arms and angular dimensions.

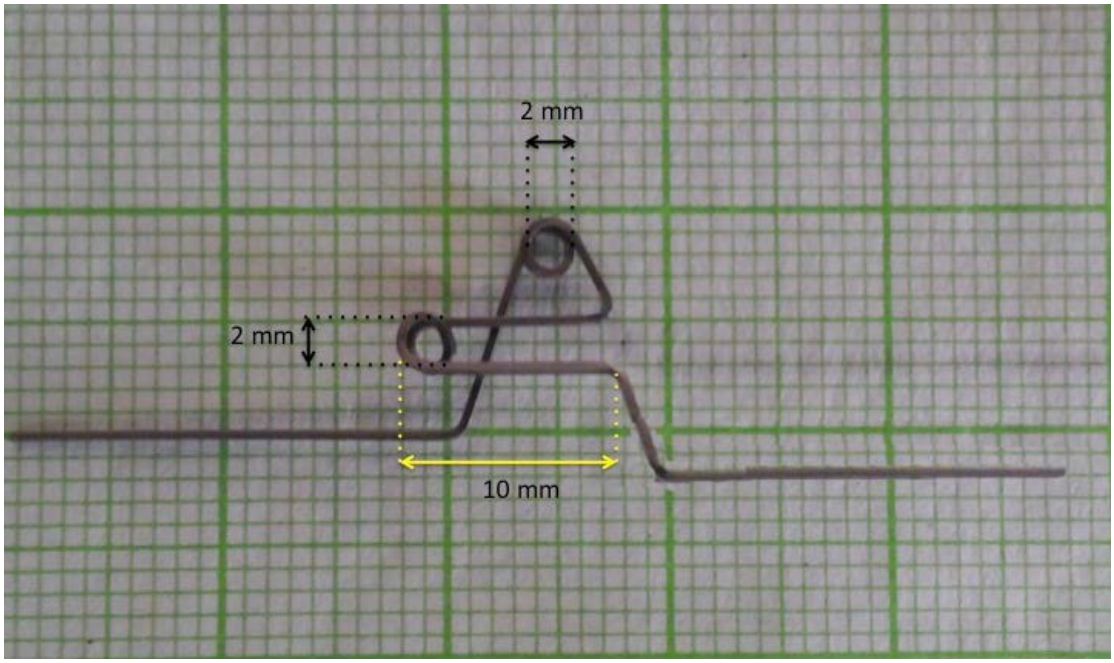


Figure 1(c). A loop horixontal arms and helix angular dimensions.

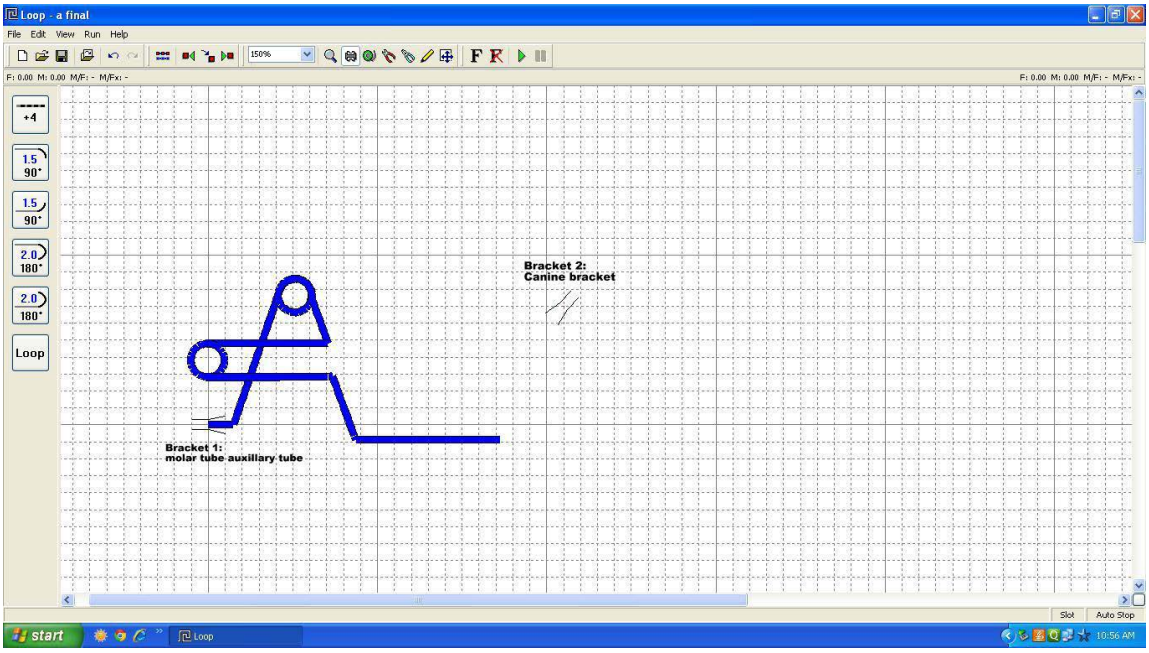
Hence to total length of wire, which is approximately bent, to form this loop is approximately 40mm. This increased length of wire offers greater flexibility and low load deflection rate. This loop delivers a moment to force ratio of 5:1 when in range of 10-12mm without any residual moments. This loop does not require any gable bends or pre activation bends before insertion. The resulting forces deliver a precisely accurate moment to force ratio of 5:1, which moves the impacted tooth accurately to its required pre-determined position. The moment to M/F ratio of 5:1 is variable and achieves a value of 10:1 once the canine is tipped distally and the long axis of canine is perpendicular to the alpha arm of the loop. The Dimensions and design of loop is shown in Figure 1(a), Figure 1 (b) and Figure 1(c).

dHAL LOOP version 1.7.0.0 a computer loop simulation software was used to design and test the loop in simulation[26]. This software simulates the forces exerted, moment to force ratio and direction of tooth movement executed by the loop when engaged between two brackets or orthodontic attachments[27].

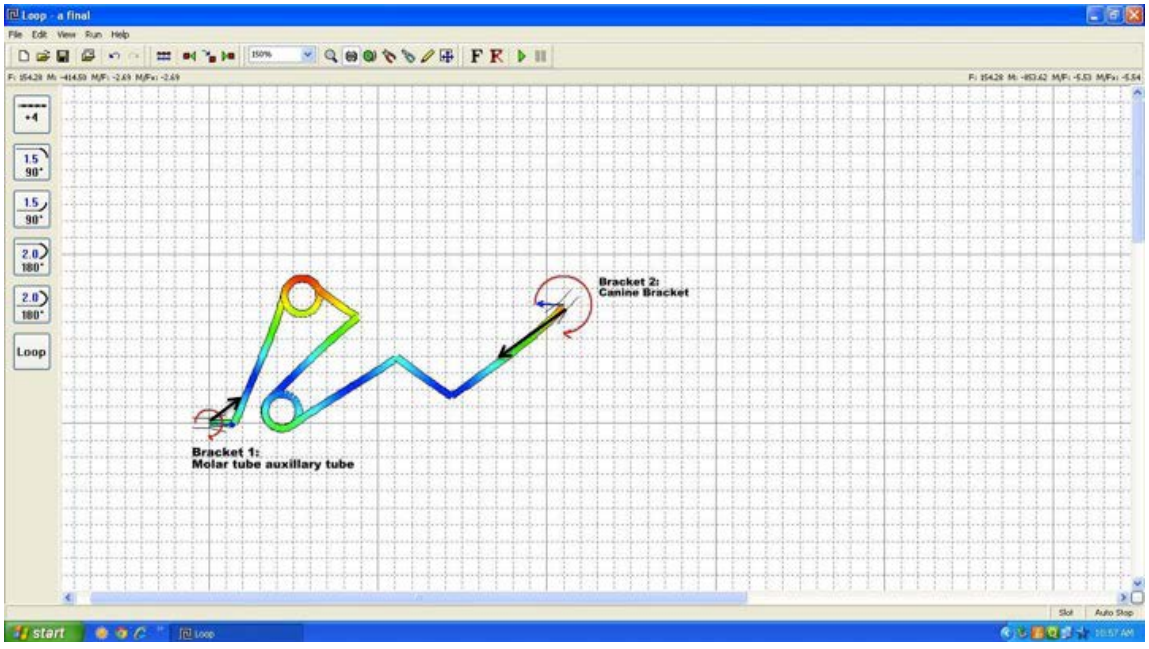
Simulation for A loop was done using this software with precise consideration of the dimension and material of wire used. Also the virtual loop in the software was fabricated using exact dimensions mentioned in the design of the loop. Figure 2(a) shows the design of the virtual A loop without activation. The one end of loop is engaged in the bracket no 1 (molar tube) and another bracket no 2 (canine) is placed in the position of blocked out or impacted canine to simulate precise activation. Figure 2(b) shows the loop after activation i.e. after both the ends are engaged in the respective bracket and molar tube The red arrow shows the moment produced by the loop and the blue arrow shows the direction of force exerted by the wire on bracket. The resultant movement of tooth is represented by black arrow. Please note that the bracket no. 2 is placed angulated in the simulation like it will be placed in the impacted or blocked out canine. Almost 78% of impacted canines are angulated mesially usually at an angulation of more than 31° to the midline[28]. Keeping in mind these findings the canine bracket was angulated in the software used for simulation of loop, to calculate the exact moment and couple system acting on both end of wire. Table 2. Shows the moment, force and M/F ratio acting on both end of wire.

3. Discussion

Until now, preparing a loop in rectangular wire for management of impacted canine has not been attempted which can be secured or anchored in the auxiliary molar tube slot. As the end of the beta (β) segment is secured into the auxiliary molar tube slot the main arch wire slot can be used to engage the main arch wire for leveling and alignment simultaneously. The end of the alpha (α)



(a)

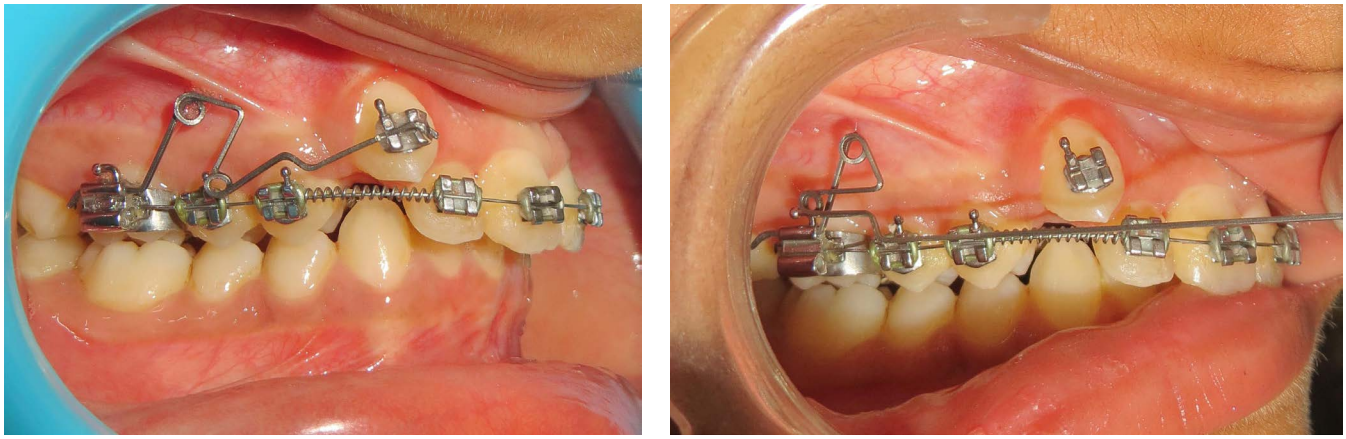


(b)

Figure 2. (a) A loop before activation. (b) A loop after activation.

Table 2. Values of force, moment and M/F ratio.

	Bracket 1 (Molar tube)	Bracket 2 (Canine Bracket)
Force	154.28 gms	154.28 gms
Moment	414.50	853.62
M/F ratio	2.69 : 1	5.53 : 1



(a) **(b)**

Figure 3. (a) A loop placed in patient after activation. (b) A loop placed in patient before activation.

segment is inserted in to the bracket of impacted canine (after exposure)/blocked out canine Figure 3(a).

The unique design of this loop enables clinician to engage the molar auxiliary tube by end of β segment and canine bracket by end of α segment directly by bypassing all the other teeth. The offset bend of 110° in the β segment of the loop bypasses the 2nd premolar bracket and thus main arch wire can be engaged even in to the second premolar bracket and alignment of all the teeth can be done by a continuous arch wire Figure 3(b). This is not possible with other loops used for impacted canine.

When the loop is inserted into the molar auxiliary tube, approximately 1mm space should be left in between the mesial end of molar tube and the 110° offset bend. The wire should be cinched back behind the molar tube so that it does not slide mesially and can be activated Figure 3(a). The length of the α arm is decided by the distance between the impacted canine and the A loop. The α arm length should be such that after engagement of the α end in the canine bracket the loop should not open up more than 75° at the helix on the top of the A. This is because the activation range of A loop is 30°, if activated more than 30° the moment to force ratio is not appropriate and also the moment is reversed which is not favorable. The force value on canine is also increased and it may cause root resorption instead of tooth movement. Hence the loop should activated in a range of 30° only. The loop can be reactivated easily by pulling the α arm more mesially to the canine bracket and re-engaging it. This can be done without removing the wire from the auxiliary molar tube. The activation of loop should be done until the canine bracket slot comes into the level of other bracket slots and can be engaged by rectangular wire.

Force exerted by cantilever arm interms of vector and magnitude is controlled in all the 3 dimensions. Required and recommended force for extrusion of impacted tooth range from 125 to 150 gms, which is effectively exerted and maintained consistently by this loop. As compared to continuous flexible arch wires this loop has less adverse effects on the adjacent teeth. Also this loop can be used even if there is limited to a single tooth malocclusion, hence unless full arch corrections are required this type of loop does not require fully bonded appliance. With the help of transpalatal arch or Nance Palatal Button the adverse forces on anchor teeth like tipping and torqueing movements can be controlled. Hence this loop can be used with any pre-adjusted system having rectangular slot molar tubes.

4. Advantages

1. As the loop is designed in rectangular wire it provides complete control over root movement of the teeth being moved.
2. The design of the loop permits to by pass the premolars and directly engage the impacted or blocked out canine and hence carry out simultaneous leveling and alignment of other teeth by continuous arch wire in main molar tube slot.
3. Adjacent teeth are not subjected to any reactionary forces hence adverse effects on them are avoided.
4. This loop generates and exerts controlled light and continuous forces working over a long range of movements which bring the tooth in the desired position.
5. The loop does not require any kind of pre-activation bends.

6. The loop can be kept pre fabricated with the given dimensions and can be directly applied in patients on first visit immediately after bonding.
7. If needed this loop can be removed and replaced without disturbing the base arch wire.
8. The loop can be reactivated easily by just pulling the alpha arm of the loop and reengaging it in canine bracket.
9. Versatility of the loop's unique design allows it to be used in multiple malocclusions such as correcting single tooth malposition like ectopically erupted canine, impacted canine or premolar.

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