A REVIEW ON DOUBLE KEYHOLE LOOP

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Abstract
Closure of extraction space in orthodontic is an important stage of orthodontic treatment. Sound knowledge and basic understanding of biomechanics is required for space closure. Extraction space can be closed either by frictionless or friction mechanics. Friction mechanics having simplicity as comparison to frictionless mechanics but the friction between bracket and arch wire decreases rate of space closure, decreases the delivery of required force level, causes loss of anchorage and also associated with uncontrolled tipping and deep bite like undesirable side effect. Simplicity of Friction mechanics or sliding mechanics makes it attractive. In friction mechanics elastics or coil springs used for close the space site and brackets slides over the orthodontic arch wire. Loop bends are used to generate force for space closure in frictionless mechanics. Different activation force and pre activation bends generate different force -moments ratio in the active and reactive units, which decide amount of anchorage. In frictionless mechanics we used many loops for different purposes. Basic structure and mechanics of double keyhole loop in space closure has been discussed in this article.
Key words: Double keyhole loop, DKL, Frictionless Mechanics, John Parker.

INTRODUCTION

Development of Frictionless mechanics occur from simple loops to more complex loop design. This loops help to generate better moment-force(M/F) ratio and delivered a constant and continuous force.[1,2,3,4,5]

The moment / force ratio is affected by the vertical height of the loops,[2] horizontal length of loop,[2] loops positioning,[2,6,7,8] extent of activation,[1,2,9,10] properties and thickness of wire[11,12] used.

Profitt, advocated the preferred location of the loops to be at the spot that would be the centre of embrasure when the space is closed for a 'fail safe' closing.[13]

John Parker of Almeda, California introduced Double keyhole loop (DKL) in Roth treatment mechanics. Usually 0.019" X 0.025" rectangular stainless steel archwire used for fabrication of DKL. This loop resembles a champagne bottle which is a mixed vertical and horizontal loop **Figure 1**. This loop is integrated in continuous arch wire. When spaces are present mesial as well as distal to canines, this DKL loop are used and closed by front backward or back forward .During retraction DKL has better canine control. DKL doesn't permit the canine to rotate during extraction space closure .In DKL arch wire 2 loops were formed on each side of a stainless steel wire. DKL has good control of the involved dental groups when performs a broad range of movements.

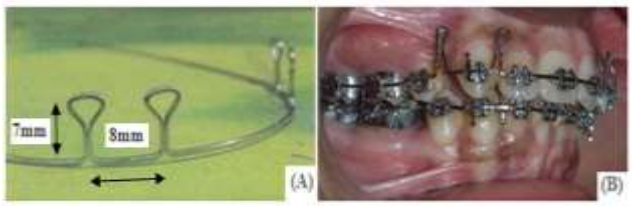

Figure 1: (A) and (B) Double keyhole loop

In Double Keyhole Loop arch, the dental arch having two posterior and one anterior sector Extraction sites present between two posterior and one anterior sector. includes Incisors and canine are the part of Anterior sector and premolar and molars forms the posterior sector. First premolar includes in anterior sector In case of second premolar extraction . Figure 2

Figure 2: A and C – Posterior sector, B –Anterior sector

Dimensions of DKL:

DKL having two symmetrical loops on each side near the canines that resemble key eyelets with 7 mm of height. Distance between two loops of same side is approximate 8 mm **(Figure. 1A)**; Leaving approximately2 mm of wire on each side of the slot of the canine bracket for the activation. Themesio-distal width of the incisors decide the distance between two mesial loops. Both mesial and distal loop having equal distance from the brace of each canine.

On the basis of mesio-distal width of incisors preformed DKL arches are also available. Commercially available DKL in various dimensions are ample for different dental arches. Scale **(Figure. 3)**: 22 , 24 , 26 , 28 , 30 , 32 , 34, 36 , 38 , 40 , 42 , 44 , 46 (in millimetre).

Figure 3 : Scale in millimeter

Indispensable requisites for installation of DKL:[14, 15,16]

1. The anterior sector should be diastema free and consolidate with ligature wire to maintain close proximal contact.
2. A DKL arch, placed on well aligned dental arches and previous arch wire sequence fully expressed torque on each tooth.
3. Dimension of DKL must be similar to previous rectangular arch wire to allow an easy insertion and perfect sliding of the arch in the slots of the braces.

ACTIVATION:

Two different mechanical concepts followed by DKL arch for space closure:

1. Use of the arch as a spring

When we use DKL arch as a spring, extraction space close by loops activation by opening the loops. Loops try to come back its original form, so its generate a constant and continuous closure force. This activation can be done in two ways:

A. Activation by distal traction of the arch (Figure. 4): By pulling the arch for opening the loops from behind the molar tube for activation. Activation of loops should not be more than 1 mm. Cinching the arch wire behind the molar tube the scheme is completed and this way we maintain this activation.[15]

Figure 4: Activation by distal traction of the arch

The activation response by cinching the arch is exhibited in two time periods; a crown retro inclination occurs at the anteriors (incisors and canine) level in the first period and in the second period torque of incisor and canine torque are regain. For this recuperation we must prolong the time between activations.[15]

The tension accumulated in the loops are absorb by the perio dontium of teeth which are widened in orthodontic treatment which aggravating fast loop closure. The persistence of the stimuli required on the periodontium for the resorption and apposition process. The palatal or lingual portion of the incisors alveolar socket and the distal portion of the canine alveolar socket are the zones that first absorb the activation forces of the DKL, resulting in retro inclination of these teeth. In the canine, this upright inginclines mesially and incisally the slot of the braces, guiding the arch in this direction and incrementing the arching of the Spee curve with intrusion of the lateral section and the extrusion of the anterior sector. This creates a posterior open bite and an anterior deep bite, due to it magnitude of its root surface, the canine tooth will take more time to recover its correct inclination.[15]

It should activates after 45 to 60 days. When right time, activation must be done observed clinically .The two references are:

• Any occlusal curving must not be present in DKL.

• Correct inclination of the canine is required. The arch should not be activated again if there is a curvature or the canine inclined distally. We must wait until both the situations become normal. The second phase of the movement of the incisors will not occur if the activations are more frequent.[15]

B. Activation with retroligature (Figure. 5) : A ligature wire tie in between hook of the molar buccal tube andthe distal loop of the DKL arch wireto activate this arch is another way. AWeingardt plier used for opening the loops and consolidated this activation with the ligature wire. Bending of theend of the wire behind the molar tube is not recommended . Theposition assumed by the anterior portion of the arch is the main differencebetween these two activation modes. Thedistal loop of DKL expresspalatal root torque and having gingival inclination of the anterior sector. Ligature wire used for applying traction forcein the distogingival angleof the distal loop.[15]

Figure 5: Activation with retro ligature

This has many advantages:

• The upper incisors torque recovery has improved.

• It avoids extrusion of anterior sector.

• Minimizing the crown retroinclining effect.

The activation of DKL arch with retro ligature is more appropriate. When a lot of dental retraction is needed.

2. Use as anchorage for auxiliary elements Figure 6

In posterior sector migration (anchorage loss) type of special cases we used DKL arch as anchorage for auxiliary elements. The DKL arch must remain passive in

this case with the closed loops. Distal loop of DKL arch used as anchorage for auxillary elements.

Figure 6: Use of the arch as anchorage for auxiliary elements

DKL ARCH MODIFICATIONS FOR RETRACTION WITHOUT TORQUE

The management of the DKL varies when the retraction movement has to be accomplished without torque. In this condition, movement is seldom planned for the upper dental arch, but, for the lower arch, minimal or nil torque expression is planned during the retraction of the anterior sector. To achieve this, the arch in the anterior sector must be wear off so that we can smoothen the edges to diminish the torque.[15]

DKL modifications allow mesial migration of the posterior sectors: in cases where the posterior sectors must be mesialized especially in those where a retrusion of the incisor is necessary. The DKL arch must not express a negative torque as it has an impact on the anchorage. It can be achieved by wearing off the arch wire on the distal portions of the loops to avoid the sharp edges of the wire that will in turn reduce the negative torque expression and friction. This activation is made from the first molar. Another modification is available for the same purpose by placing 15 degree positive torque in the posterior segments. This will place the molar roots onto trabecular bone. Reinforce the inferior incisor anchorage when an important inferior molar mesial movement is going to be done. A 0.021" x 0.025" DKL arch can be used to increase anterior torque. The edges of the posterior segment of the arch will be wear off. If we give positive torque in a higher caliber wire it increases friction and mesial molar migration become more difficult.[15]

When to use a two or four-loop arch?

The simple two loops arch and the DKL arch were used to close extraction space. All those cases in which first we want to distalize canines not more than 350 g force apply with closed coils or with power chain and later on by opening the loops (not more than 1mm) retrude the four incisors by the use of Simple two loops arches. Posterior maximum anchorage cases these simple arches are recommended. When extraction space closure should required in a single step the DKL arches are used, retruding en-masse the six anterior teeth the loops are activated more than 1 *mm* with posterior anchorage loss, or, if we required maximum anterior anchorage and minimum posterior anchorage.[15]

DISCUSSION

A retrusion force exert on the anterior sector by anterior keyhole when the DKL is activated, and a mesialization force work on the cuspid simultaneously a distalization force exert on the canine and a on the posterior sector a mesialization force acted by the second key. Same strength and opposite direction forces exerted on the canine , so they dissolve each other , therefore the amount of force experienced on the canine is zero. For the mesial movement of the posterior sector 300 g force should translate, but in reality due to the resistance force (364 g) of both molars (1st and 2nd molar)this does not occur. Resistance force ismore in amount as comparison to the mesialization force of the key loop so 64g retrusion force is resultant force.[15,16]

If we use a wrong sized DKL diastemas appear in the anterior sector. If we used a bigger arch instead of required size arch the mesial loop will bend over on the cuspid bracket. If only the distal loop open and the mesial loop still remain its neutral position after activation of loop then resultant force on canine is not zero and canine will distalize separately. This will create a spacing between the canines and the lateral incisors.[15]

Tábitha found in his study that mechanical force waves generated in arch wire after activation of loop were run from the posterior loop to anterior loop and they met each other at the central portion of arch and then returned and focused on the two loops, mainly in the posterior loop during the first phase of activation. So distal loop clearly having greater storage of forces., The study also shows that the amount of force increase in the anterior portion as the test progresses towards the end **Figure. 7**.[17]

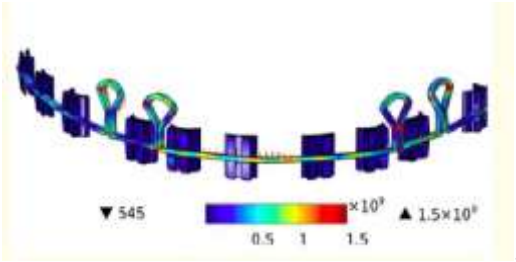

Figure 7: Frontal view showing Stress is concentrated in the loops.

Dr. Alfredo Bass[16] et al found in his study that the stainless steel wire required more force to open the loops than in TMA wire because of hardness of steel. The Hooke law followed by simple and DKL TMA arches. The amount of force exert by TMA arch was 300 g after 1 mm of activation of DKL and amount of force exert by stainless steel arch was 500g after similar activation as TMA arch.

According to Halazonetis, experimentally evaluated loops were computerized simulated and compared their response with the results and check the accurateness of the computer simulation of various loops. Various factors of orthodontic loop design are visualized by computer simulation. This computer software has special features

which computate the neutral position of loops and the shape of preactivated arch wire. [18,19]

In Fig.8 computer program wizard showing neutral Keyhole loop which having alpha and beta arm. Beta arm pre activated by 10^0 and alpha arm pre activated by 25^0. Later we activate this loop by 2 mm ,1 mm and 0.5 mm respectively in figure 8.

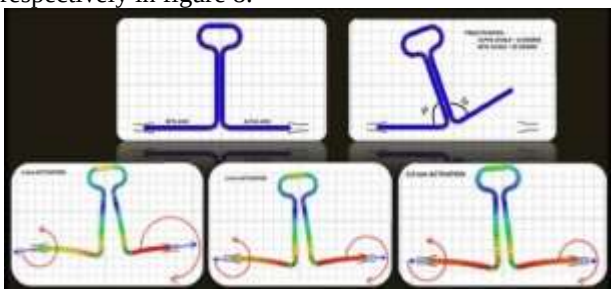

Figure 8: Computer simulation of Keyhole Loop

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