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A Review of the Different Applications of Laceback in Fixed Orthodontic Therapy

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Abstract

Objectives: The presented work explored the applications of laceback in fixed orthodontic therapy, as well as the benefits, modifications, drawbacks, and their impacts on the movements of the molars, canines, and incisors. It also looks at the data supporting its use.

Methods: About the laceback up to December 2023, a manual search and searches in numerous databases, including Science Direct, PubMed Central, Cochrane Library, Wiley Online Library, Textbooks, Scopus, Research Gate, and Google Scholar were conducted. After removing duplicate and irrelevant papers, twelve relevant studies were included in this review

Conclusions: The impact of laceback on canine retraction has been studied, and it appears to be helpful in the initial phases of treatment by creating a space for the alignment of incisors with regulated retraction. However, anchorage control procedures for posterior teeth are necessary

Introduction:

Edward Angle has been considered the "father of modern orthodontics" due to his role in classification and diagnoses of malocclusion. This is because of his creative invention of a number of orthodontic appliances, such as edgewise appliance, this appliance was designed to improve upon shortcomings of earlier models. He utilized the same bracket on all of the teeth, therefore he employed edgewise appliance to treat his patients without extraction and introduced three-order bends to achieve each patient's ideal tooth position [1,2].

Andrews [3] depending on data from 120 study models of non-orthodontic patients of normal occlusion, presented his 6 keys for normal occlusion in 1972. He then created the Straight-Wire Appliance, which included brackets with additional functions tailored to each tooth. For reducing wire bending, he moved the 3 order bends to bracket base and slot. Additionally, he created various prescriptions for class I, II, and III patients as well as extraction as well as non-extraction cases [4,5].

Further modifications were made by Roth [6] attempted to reduce the number of the brackets types required to carry out Andrews' prescription. He suggested a prescription for a set of the brackets that would work well in most circumstances, the number of brackets available was reduced. Since he thought that his prescription would require more anchorage. The Roth technique was designed with increased tip of the canine brackets and placing a distal crown point on lower buccal segments for improving canine guidance. Roth prescription has been created with increased torque in the anterior region and tip of the upper molar for preventing palatal cusps from dropping.

For further improving the results of cases which have been successfully resolved, MBT system recommended several modifications. This prescription decreased anterior tip in Roth and Andrews prescriptions to levels that were far closer to Andrews' original data. Reducing strain on molar anchoring and avoiding any growth in arch length while receiving therapy were the main objectives. A reduction in canine tip has been added to the MBT prescription for further reducing the possibility of the cuspid as well as bicuspid roots coming together and to provide the ability for the placement of crowns in a somewhat more upright posture, so lower anchorage demand will result from this. MBT technique lessens the tip on the upper posterior teeth, reducing the need for anchorage [7].

MBT prescriptions were among the most widely utilized bracket prescriptions as soon as they were made accessible in 1997. Important differences between other bracket prescriptions and this one are [8]:

1. Upper central incisor brackets with increased palatal root torque (Andrews: 7°, Roth: 12° and MBT: 17°).
2. Upper lateral incisor brackets with increased palatal root torque (Andrews: 3°, Roth: 8° and MBT: 10°).
3. Increased lingual crown torque in lower incisor brackets (Andrews: -1°, Roth: -1° and MBT: -6°).
4. Decreased tip in upper canine brackets (Andrews: 11°, Roth: 13° and MBT: 8°).

The switch from traditional edgewise appliances to pre-adjusted appliances provided the orthodontists with the ability of treating patients more rapidly while maintaining a high standard of care. The first change an orthodontist noted following switching to a pre-adjusted appliance system has been the initial inclination regarding anterior teeth to lean forward. This is because anterior brackets have a built-in point, which can be more noticeable in upper arch because of the larger built-in tip [8].

Laceback

Definition

Laceback can be defined as a stainless-steel ligature that is placed in figure-8 pattern under the archwire as part of alignment as well as leveling phase of treatment with a straight-wire appliance, often from terminal molar quadrant to same quadrant’s canine [9] as shown in Figure (1).

Types

There are 2 types of laceback; active and passive.

A. Passive laceback

The first molar and canine arch lengths are fixed. In the absence of laceback, the prescription's manifestation of the straight-wire force system lengthens the arch between the molar and the canine, which causes the incisors to incline. This is especially noteworthy when aligning and leveling is just getting started. In situations of extraction, this leads to higher root resorption and round tripping, which may be detrimental to gingival health. The force system causes the canine to tip its distal roots, which is typically a good outcome, and a passive laceback fixes the arch length, so it cannot expand [9,10].

B. Active laceback

To create an active force between the first molar and canine, laceback is tightened. Over the course of the appointment interval, this results in a strong beginning force (interrupted force) that decreases. The molars are mesialized as a result of the reciprocal forces acting on the canine throughout such phase [11].

Uses

The uses of every one of the types could be listed as follows [10,11]:

A. Uses of a passive laceback

1. Regulates the mesial canine tip for reducing incisor proclination throughout alignment.
2. Fixes distance between the canine and molar teeth.
3. Provides protection for unsupported wire span throughout the initial alignment process.

B. Active Laceback Uses

1. Retracting canines
2. Mesializing the molars
3. Aiding in the dental center line corrections when applied in a unilateral manner.

Laceback uses can be indicated as followed [10-12]:

1. Preventing or reducing canine mesial crown tip

As mesial tip in a canine bracket is expressed when a canine tooth is either distally angulated or upright, initial arch-wire engagement into bracket will cause an angulation to the mesial crown. They will inevitably cause the incisors attached to the same wire to procline. In order to mitigate this effect, laceback maintains the canine crown in a sagittal position by tying it back to the terminal molar, which promotes the movement of the distal root rather than the movement of the mesial crown tip, which would otherwise change the canine's angle. Whether this happens to necessary theoretical extent in practice is up for discussion.

2. Correction of the dental midline

To help the correction of dental midline, it is possible to use the unilateral laceback for restricting the movement of mesial canine crown on one side and allow expressing contralateral mesial tip. The dental mid-line will therefore move to the side as a result of laceback.

3. Protection of the archwire from the masticatory forces

In particular, at the sites of premolar extraction in which the first archwire is unsupported over a longer inter-bracket span, masticatory forces, particularly over food boluses, could produce vertical forces which might result in thin first archwires to detach from molar tubes or bands. There is considerable protection against this occurring because to the laceback.

4. Canine retraction and mesial molar movement

To initiate the retraction of the canines in cases of severe crowding of lower incisors, tight lacebacks may be used. It is not that likely that they be extremely successful, though, due to the fact that they will only be active over a highly limited range. On the other hand, it is expected that the movement of the mesial molar will compromise posterior teeth's anchorage.

Mode of action

Three factors could be used to understand the laceback's mode of action [11]:

Firstly, through preventing the canine crown from mesializing, it affects the way the fixation of the length of the arch between canine and molar is fixed. Thus, the canine center of rotation shifts, migrating to canine bracket, with the moment primarily expressing itself at apical region as shown in Figure (2).

Second, retraction of the canine by laceback may be described by the tip of the crown tilting slightly distally, succeeded by a period of rebound brought on by the archwire's influence on the tip of crown, throughout which the distal movement of crown root is accomplished as shown in Figure (3).

Thirdly, a canine could be retracted by the passive laceback using the trampoline effect and occlusal forces. The dentition (trampoline) moves microvertically due to biting forces, resulting in laceback briefly bending. The laceback bending retracts canine and shortens its anteroposterior length. Chewing/function repeats this procedure several times.

Advantages

1. Inexpensive [9].
2. Less chair-side time [9].
3. Easy to perform [9].
4. Patient cooperation is not needed [9].
5. In the sagittal, vertical, and transverse planes, it led to more carefully controlled canine movement [13].
6. It could accept various modifications [11,14,15].

Disadvantages

Gill and Naini [11], Barakat *et al.* [16], and Fleming *et al.* [17] summarized the next laceback drawbacks:

1. Compared to the movement of a power chain or a NiTi closed coil spring, canine movement is slower and less frequent.
2. Wire breakage, looseness and detachment.
3. It is complicated to determine the force of ligation.
4. Each visit, activation is needed.
5. It might impact the posterior teeth' anchorage.
6. It could lead to hampering the measures of oral hygiene [18].

Modifications

An examination of the literature indicates that there are 3 variations on laceback. The first was created by Jongbundan [14], who assessed how well this modification prevented posterior anchorage loss by tying a knot close to the second premolar bracket's mesial side as shown in Figure (4). A benefit of this modification over a regular laceback was reduced posterior anchorage loss.

The second alteration was implemented by Chain *et al.* [15] utilizing modified laceback for retraction of canines with the assistance of a push coil spring. Ordinary lacebacks and another one with the ends crossing mesially to canine have been inserted prior to when archwire was implanted. An 8 mm open coil spring is placed inside the brackets to hold the archwire in place, and metal ligatures are used to secure the canine bracket. As the ligature winds the coil spring onto the wire, it compresses it and closes it. The open ligature ends are moved in the direction of the canine. As open coil spring unwinds, canine is propelled distal. This modification is beneficial due to the fact that it has continuous force application, a low force ratio, and instantaneous laceback reactivation as shown in Figure (5).

The completely twisted laceback was referred to as the third alteration by Naini and Gill [11]. In situations when mesial tilting of canine crown is a concern, laceback could be twisted fully. To firmly fasten canine, premolar (s), and molar together, stainless-steel ligature is twisted across inter-bracket spans continuously as shown in Figure (6).

Evidence about laceback

A number of studies, gathered between 1989 and 2023 and arranged chronologically examined the impact of laceback.

In the year 1989, Robinson conducted his first study on laceback effectiveness in the leveling as well as aligning stage on lower arches of 57 cases of extraction [19]. In around half of the treated cases without lacebacks, his findings showed that the lower molars and lower incisors advanced by an average of 1.53mm and 1.47mm, respectively. With regard to laceback individuals, lower incisors advanced distally by an average of 1 mm, but lower molars advanced 1.76 mm on average. This suggests that there is more anchoring molar loss along with distal incisor shifting. There were no data on the maxillary teeth, and the mandibular teeth were the only ones studied in this study arch. The experiment has never been published, and its scope is questionable since it was a prospective study rather than a randomized clinical trial. Furthermore, it was not taken into account that there could be a large difference in the forces produced by the orthodontist during laceback placement.

Usmani *et al*. [20] have made the attempt for assessing canine laceback effectiveness on maxillary incisor proclination with respect to the pre-treatment of the tip of the canine in a randomized clinical experiment with the use of Roth prescription. They have reached the conclusion that the canine laceback results in some retroclination of the upper incisors and prevents an overjet increase throughout initial aligning phase of edgewise fixed appliance treatments. It also has a negligible impact on mesial molar movement and has an impact of approximately 1 mm on the prevention of the proclination of the upper incisor at the beginning of treatment process. Never-the-less, this effect is negligible and could not be therapeutically important. In addition to that, canine laceback effects are similar regardless of the angulation before treatment; that is, even in cases where the canine was distally tipped, the overjet is likely to rise. This experiment was limited to gathering data on the maxillary teeth because there have not been any locations in mandible that might be utilized as fiducial points. The sample size, which was modest for this kind of trial and ignored the possibility of a sizable variation in the forces used by orthodontists throughout laceback implantation, was another flaw in the study. Irvine *et al*. [21] have carried out a randomized clinical trial for 3M Unitek Dyna Lock pre-adjusted edge-wise brackets with Andrews' prescription for the purpose of evaluating laceback ligature effects on mesial position of mandibular first molars, and the anteroposterior as well as vertical position of the lower incisors. They found that there was a 0.75 mm increase in mesial mobility in the lower first molars in the study group. As a result, there was a clinically and statistically significant increase in posterior anchorage loss as a result of the lower first molars' mesial movements when laceback ligatures were applied. However, over the course of the experiment, neither group's lower incisors showed any statistically significant variations in labial segment relief crowding or in vertical or anteroposterior location with respect to the lower labial segment. Nor were the effects on the upper teeth and the possibility of a large variation in the forces that are used by orthodontists throughout the placement of the laceback discussed.

Using a Roth prescription, Sueri and Turk [13] investigated the effects of laceback ligatures and NiTi closed coil springs on mesial molar movement and maxillary canine distalization throughout the phase of leveling and alignment. With regard to laceback group, they discovered that the molar had moved and tipped mesially (0.70mm and 3.90°) and canine moved then tipped distally (1.67mm and 4.50°). In coil spring group, the canine migrated and tipped distally (4.07mm and 11.63°) and the molar had moved and tipped mesially (1.93mm and 3.10°). The conclusion that they have reached is that laceback ligatures were successfully used to achieve the distalization of the canine. Overall, canine movement was slower and less frequent, but it was better controlled and took place in sagittal, transverse, and vertical planes. They have illustrated laceback ligature characteristics on canine through applying a slight canine tip and compressing periodontal ligament. The canine crown's range of motion is limited by periodontal ligament width and the elasticity of alveolar crest. There were issues that are related to this experiment since it has not been randomized, the size of the sample was small, and the mandibular teeth were not evaluated. Additionally, there is no unique force mechanism—like a laceback or NiTi coil spring—that might be responsible for posterior movement with respect to the upper incisors. It is possible to argue that the retraction of the canines leads to the retraction of the upper incisors. The amplitude of the force and its effect on mandibular teeth were not examined.

Khamabay *et al.* [22] have evaluated intensity and repeatability of forces that are produced by ten physicians throughout the process of the placement of laceback with the use of force-measuring typodont. They have discovered that only a small number of operators used the same forces in the case when placing lacebacks on 2 different cases, with the six forces which doctors produced varying from 0 to 11.1 Newton. Throughout laceback installation, a clinician cannot utilize any method in order to measure the force that are used in order to tighten laceback. In this experiment, a 0 Newton force has been recorded by two operators since some orthodontists may want to leave the laceback "passive," while other orthodontists might view a higher force as "necessary." There is not much immediate feedback from patients on force that is generated through laceback because any discomfort will sometimes arise later and could be made worse by forces that are caused by an accompanying archwire alteration. Jongbundan [14] conducted a comparison of laceback ligature effects and their modifications on anchorage loss in MBT system. He had discovered that the standard laceback approach, which significantly minimizes posterior anchorage loss, causes less mesial movement of maxillary 1st molars and 2nd premolars than the modified laceback approach, which adds a twist mesial to the second premolar bracket. The improved laceback will integrate posterior anchorage as a single unit, on the contrary with the conventional laceback, which linked ligature wire in a figure-eight pattern from the upper second molar tube to the canine bracket and was unable to limit mesial movements of the 2nd premolars. The 2nd premolars in the normal laceback group could have shifted mesially as a result of constriction around the extraction wound and natural tooth movement. This study disregarded the lower teeth, was non-randomized, and had a small sample size.

In order to determine how laceback ligatures affected mesial position of maxillary first molars as well as the sagittal and vertical positions of the maxillary incisors throughout stage of alignment and leveling of the orthodontic treatments of the Class II division 1 cases that require upper first premolar extraction, Barakat *et al.* [16] carried out a randomized clinical trial. They discovered that retroclination of the maxillary incisors might cause laceback ligature to distalize the maxillary canines. There is no evidence linking the shift in the maxillary incisors' vertical position to laceback ligature. Furthermore, anchorage loss occurred irrespective of the laceback ligatures.

Moresca *et al.* [23] investigated negative and positive laceback effects on the anteroposterior position of central incisors and maxillary first molars in two groups with the use of the MBT prescription. In the first group, the canines have been retracted by active lacebacks, which were reactivated each month until the incisors were in alignment. The lacebacks of the 2nd group have been passively fitted (no force of retraction over canine brackets), and have only been altered in the wire fracture events. They have discovered that the maxillary first molars' anchorage was lost as a result of active laceback, but passive laceback had no influence on the location of these teeth. To inhibit the proclination of the central incisor, lacebacks, whether active or passive, were effective. The study did not look at mandibular teeth, had a small sample size, and was not randomized.

However, Awni [24] examined the rate of space closure, tilting, and rotation of canines throughout their retraction through tieback and laceback with the use of traditional ceramic brackets along 2 distinct archwire types (0.020 and 0.017x0.025-inch) with the use of a typodont modeling system. They have discovered that a round cross section archwire significantly enhanced the space closure rate, degree of tilting, and rotation when canines were moved over it. Additionally, they found that laceback ligatures have been shown to help in canine distalization. Furthermore, the tieback retraction approach of sliding the canines produced highest average value for space closure rate when compared to laceback.

A comprehensive evaluation was conducted by Fleming *et al.* [17] in order to assess the evidence of laceback effectiveness in the regulation of incisor position throughout the initial alignment process. The use of lacebacks did not have a statistically or clinically significant effect on the incisor and molar sagittal positions during first orthodontic alignment, according to their claim based on the available data. There is no evidence about how chair side time or periodontal health are affected by lacebacks.

The efficacy and efficiency of active laceback ligatures and Mulligan bypass arch were compared by Chetan *et al.* [25] for degree of retraction, rotation, and tipping of maxillary canines with the use of the MBT prescription. They have discovered that both the Mulligan bypass arch as well as the active laceback ligature provide adequate canine retraction. Compared with the active laceback group, the Mulligan bypass arch significantly decreased distal tipping and distopalatal rotation amount and increased tooth movement rate in a given time amount. An active laceback ligature, on the other hand, is only beneficial when the canine tip is mesial and only requires 2-3 mm of space. In such non-randomized trial, the canines were retracted with the use of completely different techniques (power chain with stainless steel archwire versus laceback with NiTi archwire), an indeterminate amount of retraction force, and an inadequate method of assessment were the major limitations of that study.

Using the research models and cephalometric studies, Rajesh *et al.* [26] assessed the anchorage loss amount and percentage after initial leveling and alignment using MBT and Roth prescriptions. They have reached the conclusion that using laceback and cinch back led to clinically and statistically significant anchorage loss increase, particularly when posterior anchorage was not improved, which appeared to be more noticeable than with the MBT because the anterior section of the Roth prescription had a greater tip. Once more, the study was non-randomized and had a small sample size.

Recommendation

Based on the aforementioned evidence, randomized clinical trials are necessary for the purpose of verifying clinical effectiveness of lacebacks in canine retraction on different archwires [27]. These trials must also assess the mesial movement of molars as well as the distal movement of incisors when using various laceback modifications, including different bracket slot sizes and prescriptions, multiple canine angulations, quantifiable force, and treatment of both the mandibular and maxillary arches.

Conclusions

For the first time, a thorough explanation of the varieties, applications, benefits, drawbacks, and modifications of laceback ligatures was provided in this paper. The evidence was carefully explained, with a focus on how it affects incisors proclination, canine angulation and molar anchorage loss. In the early phases of treatment, laceback's influence on canine retraction appears to be advantageous in that it creates a space for alignment of incisors with controlled retraction; nevertheless, anchorage control methods for posterior teeth must be implemented.

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Disclosure of any Conflict of Interest

Conflict of interest: None declared.

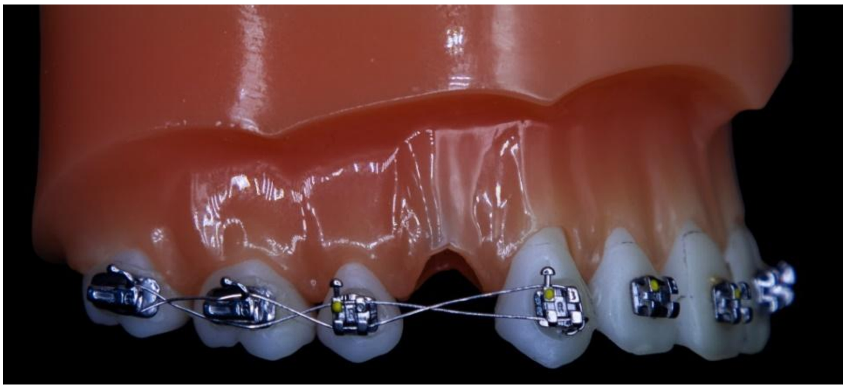

Figure (1). Laceback

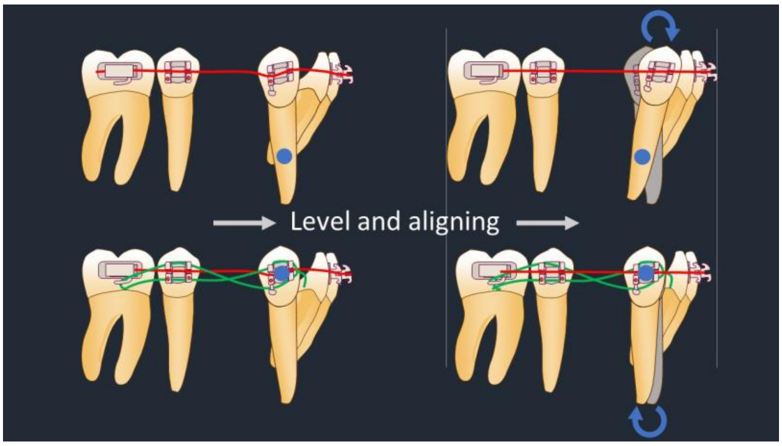

Figure (2). Effect of laceback on canine during leveling and aligning stage

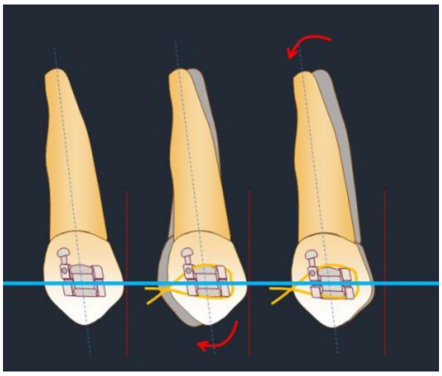

Figure (3). Canine retraction using laceback

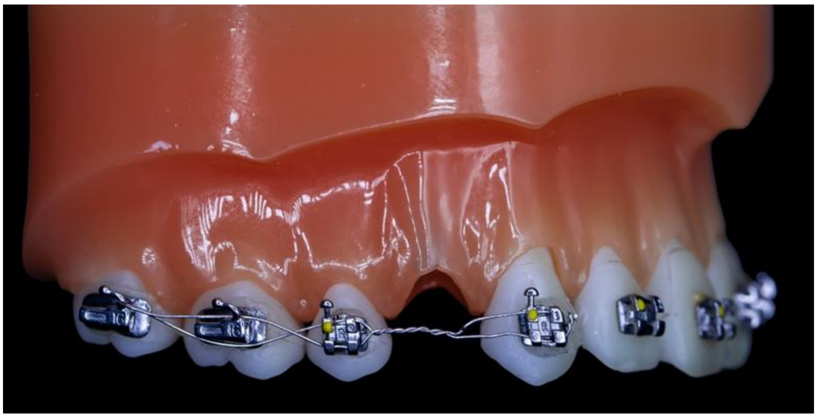

Figure (4). Modified laceback technique with a knot closed to mesial side of second premolar

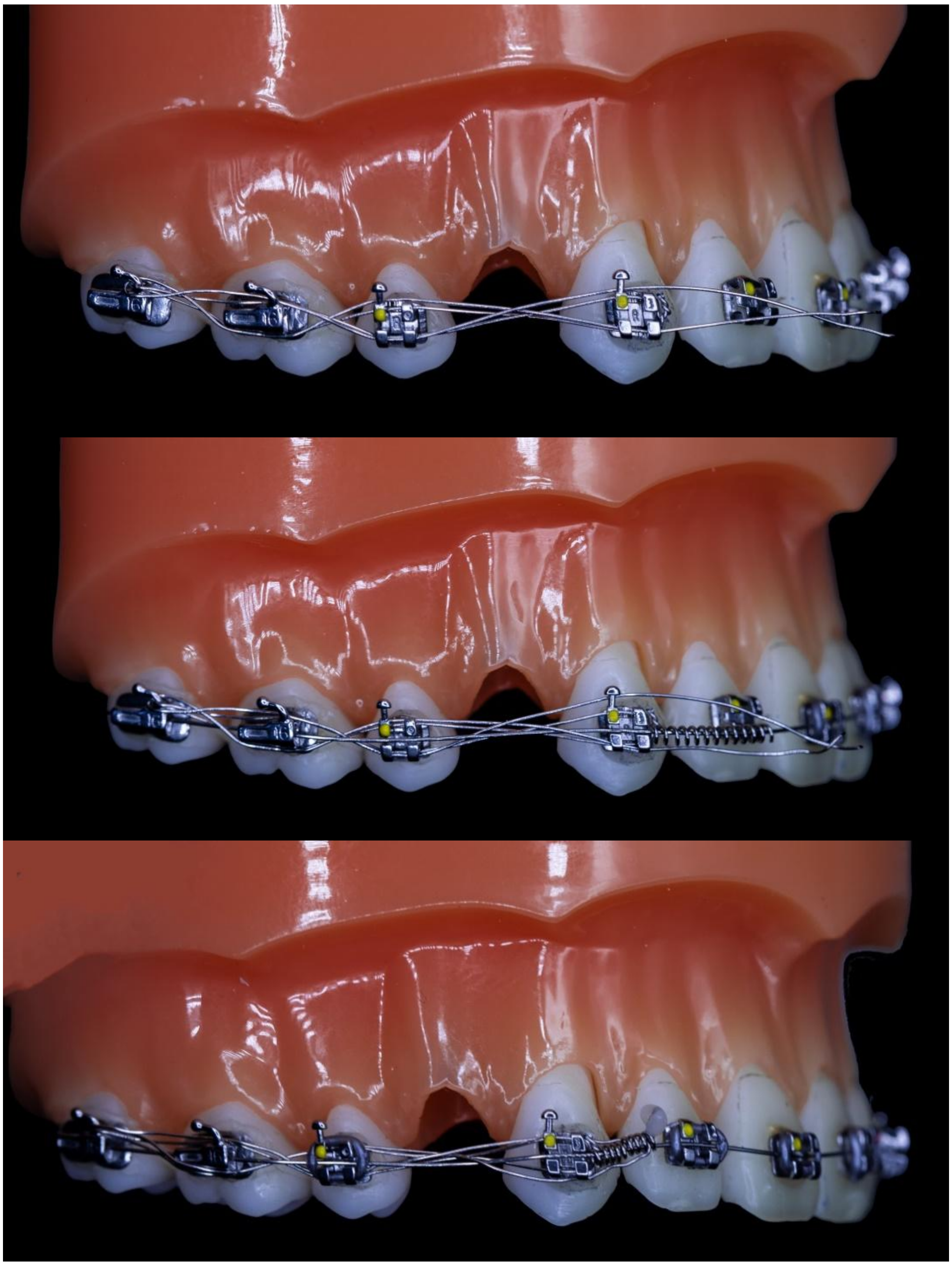

Figure (5). Modified active laceback for canine distalization

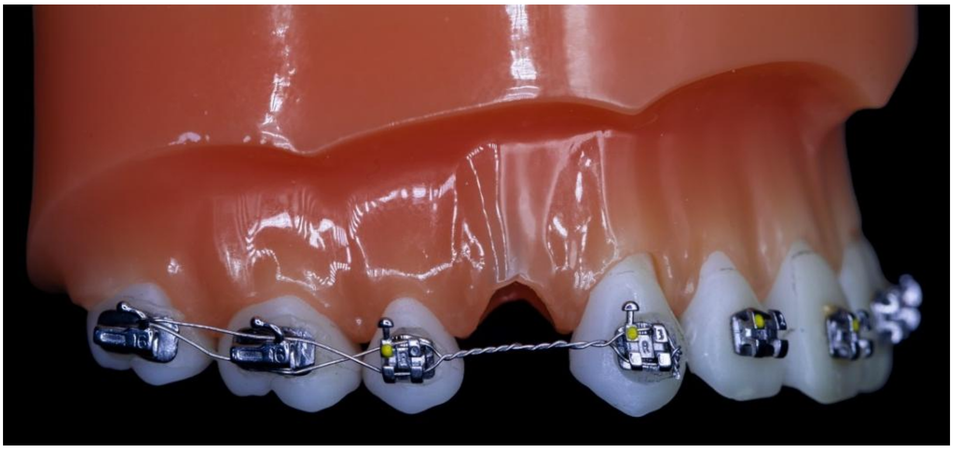

Figure (6). Fully twisted laceback

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