COMPARATIVE CLINICAL EFFICACY OF SEGMENTAL T LOOP AND GEOMETRY-X IN THE ALIGNMENT OF MALPOSITIONED CANINES: A PROSPECTIVE CLINICAL AND RADIOGRAPHIC ANALYSIS

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ABSTRACT

Aim: To compare the rate of individual labially placed canine retraction with Segmental T loop and Geometry-X.

Material and method: A randomized split-mouth clinical trial was conducted on 10 patients (20 canines), with one canine retracted using a Segmental T-loop and the contralateral canine using a Geometry-X. Parameters assessed were rate of retraction, canine rotation, distal crown tipping, anchorage loss, and root resorption, evaluated using pre- and post-treatment CBCT scans and study models.

Results: Geometry-X demonstrated a slightly higher mean retraction rate (0.79 mm/month) than Segmental T-loop (0.73 mm/month). Statistically significant canine rotation was observed with Geometry-X (34.5° vs. 15.4°). Anchorage loss was significantly lower in the Geometry-X group (1.75 mm vs. 2.65 mm). Distal crown tipping and root resorption were comparable.

Conclusion: Geometry-X offers advantages in terms of speed and anchorage preservation but induces more rotational movement. It is a viable alternative when anchorage control is prioritized, though rotational side effects must be managed.

INTRODUCTION

A core objective of orthodontic treatment is to establish functional occlusion, improve esthetics, and maintain oral health.[1] Among the various challenges in orthodontic therapy, canine retraction plays a crucial role, particularly in cases requiring extraction of first premolars to manage crowding.[2]

The maxillary and mandibular canines play a crucial role in maintaining dental arch harmony and establishing a functional occlusion. Their movement in orthodontic treatment is particularly complex due to high anchorage demands and their strategic position within the arch. Effective canine retraction requires careful biomechanical planning to ensure controlled tooth movement while preserving the stability of adjacent teeth, maintaining root integrity, and protecting periodontal health.[3]

Orthodontic tooth movement is largely influenced by the characteristics of the applied forces, including their magnitude, direction, and moment-to-force ratio, as well as the condition of the patient's periodontal tissues. These factors collectively determine the remodeling response of the periodontium, which in turn governs the rate and nature of controlled tooth movement.[4]

The goal of orthodontic research has always been to develop newer methods that would emphasize on more efficient tooth movement.[5] The method employed depends on the anchorage requirements unique to the patient's situation.[6] Many fixed appliance methods are used, and each has advantages and disadvantages of its own.

Space closure with fixed appliances can be accomplished through either friction or frictionless mechanics. It is achieved either through en-masse retraction of anterior teeth or a sequential approach involving individual canine retraction followed by incisor retraction.[6]

In friction-based mechanics, various auxiliaries—including NiTi coil springs, active tiebacks, and elastomeric chains—are commonly used to deliver controlled orthodontic forces. Additionally, several commercially available specialized devices, such as the HYCON system and periodontal distraction appliances, have been developed to facilitate efficient and precise space closure.[7] In frictionless mechanics, tooth movement is achieved through various loop configurations, including T-loops, K-SIR loops, Opus loops, Modified Marcotte springs and PG springs etc. which generates controlled forces and moments.[8]

An efficient method for space closure is individual canine retraction performed prior to incisor retraction.[9] The canine is initially retracted individually to complete contact with the tooth distal to the extraction space followed by retraction of the incisors, as required to relieve anterior crowding. It is less detrimental to the anchorage to close in two steps, as opposed to retraction of all six anterior teeth at once.[10] However, this method may have some potential drawbacks such as necessitating more time and work to re-level and re-align.[11]

The T-loop fabricated from 0.017x0.025-inch TMA wire, designed by Dr. Charles Burstone, became a cornerstone of the segmented arch technique.[12] A key feature of the T-loop is its ability to offer a controlled moment-to-force (M/F) ratio which can be further adjusted for different tooth movement, such as tipping, translation, or root movement.[13]

In 2006, Dr. Chetan Jayade introduced Geometry-X mechanics as an innovative method for simultaneously retraction and alignment of labially placed canines. This method uses simple biomechanics, employing a 0.016” NiTi wire engaged in a vertical slot in the canine bracket and an elastic thread to apply light retraction force while creating a root uprighting moment during the retraction process.

The present study was conducted to compare the efficacy of Segmental T-loop and Geometry-X during the alignment of labially placed canine. A randomized split-mouth clinical trial was undertaken to evaluate the comparative effectiveness of the two techniques during individual canine retraction.

MATERIAL AND METHODS

This split-mouth study was carried out on 20 canines from ten patients. The study protocol was approved by the Institutional Ethical Committee, and informed written consent was obtained from all participants prior to inclusion.

The inclusion criteria were absence of congenitally missing teeth (excluding third molars), Class I molar relationship with bilaterally labially positioned canines and mild to moderate crowding, no history of previous orthodontic treatment, good periodontal health, and treatment plans indicating extraction of maxillary first premolars.

Initial orthodontic records included detailed case history, extraoral and intraoral photographs, pre-treatment impressions, lateral cephalogram, panoramic radiograph, and CBCT scans.

Patients were alternatively divided into two equal groups. In Group A, canine retraction was performed using a Segmental T-loop on the right side and Geometry-X on the left, while in Group B, the mechanics were reversed (Geometry-X on the right side and Segmental T-loop on the left). This ensured that an equal number of canines were treated with each retraction technique.

After the extraction of 1st premolars in both the quadrants of either the maxillary/mandibular arch, all the patients were strapped up with 0.022” slot MBT prescription. Banding was done on 1st molars with prefabricated bands containing double tube (Main slot and Auxiliary slot). The 2nd premolar and 2nd molar were also bonded. A posterior segment including 2nd premolar, 1st and 2nd molars were prepared by laceback and a 0.019x0.025-inch stainless steel wire was engaged to act as an anchorage unit. A MBT prescription bracket was bonded on the canine which was retracted using Segmental T-loop and a Begg bracket with vertical slot was bonded on the canine which was retracted using Geometry-X. All the remaining anterior teeth (Central and lateral incisors) were left unbonded. Segmental T-loop and Geometry-X were placed in the allocated quadrants as chosen by the randomization procedure.

Retraction appliances were fabricated and placed according to the assigned mechanics. The pre-retraction space between the distal surface of the canine and the mesial surface of the second premolar was measured bilaterally using a vernier calliper.

Patients were reviewed at 28-day intervals. At each visit, intraoral photographs were taken, and the space between the canine and the second premolar was re-measured. Follow-up continued until adequate space was achieved for the alignment of central and lateral incisors. At the end of the retraction phase, post-retraction orthodontic models and CBCT scans were obtained.

Appliance fabrication and insertion:

Segmental T-loop

The Segmental T-loop is fabricated from a 0.017x0.025-inch TMA wire and designed as described by Burstone, as shown in Figure 1(a). The T-loop was preactivated to generate the desired moment-to-force ratio as depicted in Figure 1(b). Anti-rotation bends were incorporated at both mesial and distal arms as shown in Figure 1(c). After the pre activation, distal arm of the T-loop was engaged in the auxiliary molar tube and the mesial arm was engaged into the canine bracket and cinched anteriorly. The distal arm of the T-loop was pulled posteriorly till the desired force as measured on the Dontrix gauge was generated and cinched posteriorly to start the retraction.

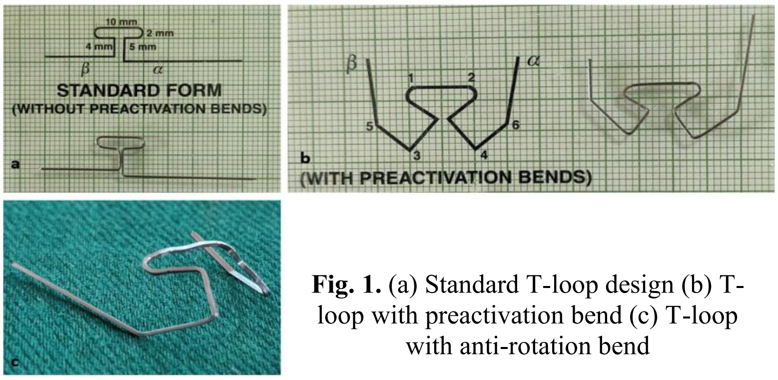

Fig. 1. (a) Standard T-loop design (b) T-loop with preactivation bend (c) T-loop with anti-rotation bend

Geometry-X

Geometry-X consist of a Begg bracket with a vertical slot which was bonded on the canine. The 0.016-inch NiTi wire segment was engaged posteriorly into the auxiliary molar tube and the anterior part passes through the vertical slot of the canine bracket from gingival to the incisal direction. The anterior and posterior ends of the wire were cinched. The desired retraction force was applied by an elastic thread measured using Dontrix gauge.

Placement and Activation:

Placement of Geometry-X and Segmental T-loop was done in the respective quadrants as decided by the randomization process & activated to deliver the retraction force as shown in Figure 2.

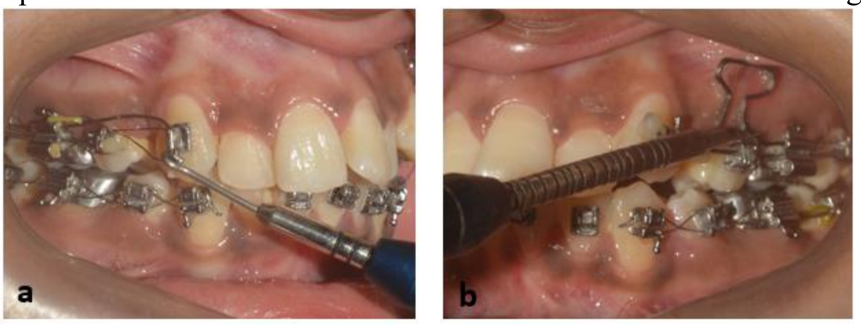

Fig. 2. Placement and Activation with (a) Geometry-X and (b) Segmental T-loop

Rate of Canine Retraction:

The rate of canine retraction was measured as the distance travelled by the canine, divided by the number of months taken for canine retraction. The distance between the pre and post space between the canine and the 2nd premolar gave the distance moved by the canine. This divided by the number of months gives the rate of retraction.

Canine Rotation:

The rotational change in the canine position was measured in the occlusal CBCT images using the Ziegler and Ingervall method.[14] Standardization of image to exact 1:1 ratio was not necessary as the angular changes are independent of the linear measurements. The rotational changes in the canine between pre-retraction and post-retraction image were measured for right and left side by marking the mid palatal raphe for the maxilla and lingual frenum, the mesiobuccal cusp tips of right and left second molar for mandible. (Figure 3)

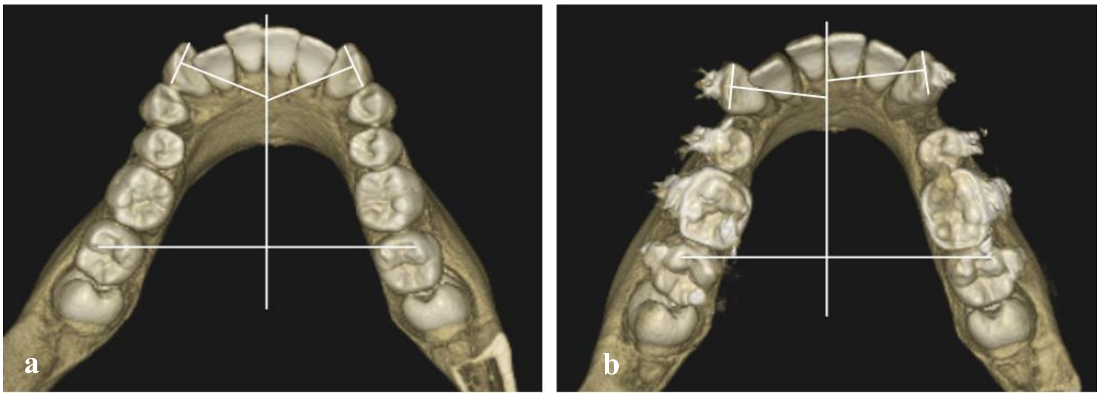

Fig. 3. (a) Pre-treatment and (b) Post-retraction occlusal CBCT images to measure the degree of rotation of canine during retraction

Distal crown tipping of canine:

The distal tipping of the canine was evaluated using a two-dimensional OPG image derived from the patient's CBCT scan. The long axis of the canine tooth was identified, and a line was drawn along this axis. A reference line, typically the occlusal plane, was then established. The angle formed between the canine's long axis and the reference line was measured to assess the degree of tipping. By comparing these angular measurements between pre-treatment and post-retraction scans, the extent of distal crown tipping of canine during orthodontic movement was quantified. (Figure 4)

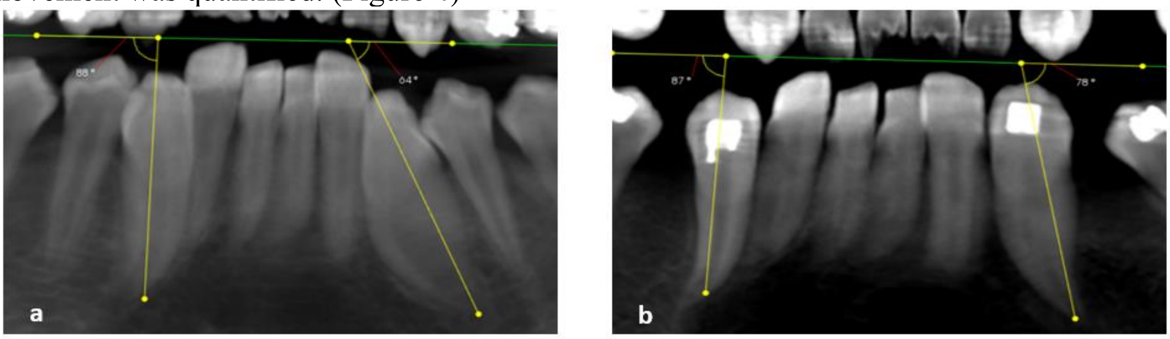

Fig. 4. (a) Pre-treatment and (b) Post-retraction images to measure the degree of distal crown tipping of canine during retraction

Anchorage loss:

Anchorage loss was recorded by measuring the movement of the molars, in millimeters, in the direction opposite to the applied orthodontic force. This displacement indicated the extent to which the molars shifted during treatment. Same size photographs of the pre-treatment and post-retraction cast were taken with equal magnification and then printed. The distance between the third rugae and the perpendicular line from the mesiobuccal cusp of 1st molar to mid-palatal raphe was measured as depicted in Figure 5. The difference in the measured distance on the pre-treatment and post-retraction cast photographs was calculated to identify the anchorage loss.

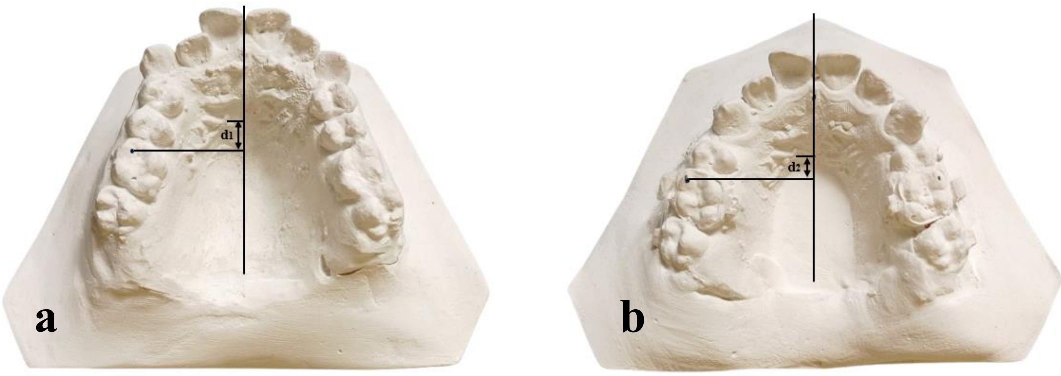

Fig. 5. Linear measurement d_1 & d_2 on (a) Pre-treatment and (b) Post-retraction cast to calculate anchorage loss

STATISTICAL ANALYSIS

The collected data were entered into Microsoft Excel and analyzed using IBM SPSS Statistics version 30.0 (IBM Corp., Armonk, NY, USA). The normality of data distribution was assessed using the Kolmogorov–Smirnov test. For continuous variables such as rate of canine retraction (in mm), degree of canine rotation (in degrees) etc., descriptive statistics (mean and standard deviation) were calculated. Since a split-mouth design was used, a Paired Samples t-test was performed to compare the mean rate of retraction, mean degree of canine rotation, mean distal tipping of canine, anchorage loss and root resorption between Geometry-X and Segmental T-loop techniques. A p-value of < 0.05 was considered statistically significant, and the confidence interval was set at 95%.

RESULTS

1) Rate of canine retraction:

In the present study, comparison of the rate of canine retraction between Geometry-X and Segmental T-loop showed that the mean rate of retraction with Geometry-X was 0.79 mm/month ± 0.23, whereas with the Segmental T-loop, it was 0.73 mm/month ± 0.36. The paired t-test revealed a t-value of 0.683 and a p-value of 0.512, indicating no statistically significant difference between the two techniques. (Table 1)

Retraction technique	n	Rate of retraction (mm/month) (Mean)	SD	95% CI of difference (Lower-Upper)		t-value	p-value
Geometry-X	10	0.790	0.238	-0.138	0.258	0.683	0.512 (NS)
Segmental T-loop	10	0.730	0.366				

Table 1 – Comparative analysis of the rate of retraction of canine with Geometry-X and Segmental T-loop

2) Canine rotation:

An evaluation of canine rotation between Geometry-X and Segmental T-loop showed that the mean degree of canine rotation achieved with Geometry-X was 34.50° ± 11.72, while the Segmental T-loop resulted in a mean rotation of 15.40° ± 14.53. These findings suggest that Segmental T-loop is significantly more effective than Geometry-X in controlling canine rotation during retraction. (Table 2)

Retraction technique	n	Degree of rotation (Mean)	SD	95% CI of difference		t-value	p-value
				Lower	Upper		
Geometry-X	10	34.50°	11.72	8.758	29.44	4.178	0.002*(S)
Segmental T-loop	10	15.40°	14.53				

Table 2 – Comparative analysis of degree of canine rotation with Geometry-X and Segmental T-loop during retraction

3) Distal crown tipping of canine:

A comparative study was conducted to evaluate the extent of distal crown tipping of canines during retraction using two different mechanics: Geometry-X and Segmental T-loop. The results showed that the mean distal crown tipping observed with Geometry X was 9.8° ± 5.18, while the Segmental T-loop demonstrated a slightly higher mean crown tipping of 11.3° ± 9.11. Despite this difference in mean values, statistical analysis revealed no significant difference between the two methods. (Table 3)

Retraction technique	n	Canine crown tipping° (Mean)	SD	95% CI of difference (Lower-Upper)		t-value	p-value
Geometry-X	10	9.800°	5.181	-6.342	3.342	-0.701	0.501 (NS)
Segmental T-loop	10	11.300°	9.117				

Table 3 – Comparative analysis of the distal crown tipping of canine with Geometry-X and Segmental T-loop during retraction

4) Anchorage loss:

A comparative evaluation of anchorage loss during canine retraction using Geometry X and the Segmental T-loop revealed a notable difference between the two mechanics. The mean anchorage loss observed with Geometry-X was 1.75 mm ± 1.88, whereas the Segmental T-loop resulted in a higher mean loss of 2.65 mm ± 1.63. This implies that Geometry-X produces significantly less anchorage loss compared to the Segmental T-loop during canine retraction. (Table 4)

Retraction technique	n	Anchorage loss (mm) (Mean)	SD	95% CI of difference (Lower-Upper)		t-value	p-value
Geometry-X	10	1.750	1.88	-1.835	0.035	-2.176	0.05*

Segmental T-loop	10	2.650	1.63	(S)

Table 4 – Comparative analysis of the anchorage loss with Geometry-X and Segmental T-loop during canine retraction

DISCUSSION

Multiple treatment modalities have been employed in orthodontics to relieve anterior crowding, with separate canine retraction often recommended in cases requiring maximum anchorage. Proffit and Fields[15] advocated this approach as optimal for achieving maximum anchorage, as it allows the distribution of reaction forces across a larger periodontal ligament area of the anchor unit. However, they also noted that closing spaces in two steps rather than one would nearly double treatment time. Similarly, Roth[16] supported separate canine retraction for maximum anchorage cases but discouraged its use in moderate anchorage situations. Kuhlberg[17] further described separate canine retraction as being less demanding on anchorage since the two canines are counteracted by multiple posterior teeth within the anchor unit. To achieve the ideal balance of forces and moments, several sectional retraction springs have been designed, aiming to provide an optimal rate of tooth movement while minimizing undesirable effects such as tipping, rotation, anchorage loss, and patient discomfort.

In this study, canine retraction with the Geometry-X spring averaged 0.79 mm/month, slightly higher than the 0.73 mm/month achieved with the Segmental T-loop. While Segmental T-loop rates in the literature typically range from 0.8 to 1.5 mm/month. Keng et al.[18] and Younes MAA et al.[19] reported values of 0.87 mm/month and 1.19 mm/month, respectively. Both appliances in the present study were slower, likely due to differences in clinical technique, force application, or patient factors. Other retraction systems, including the modified Marcotte spring (1.18 mm/month; Davis et al.[20]) and PG spring (1.91 mm/month; Ziegler and Ingervall[14]), achieved faster retraction, suggesting that while Geometry-X is effective, its efficiency is lower than some established springs.

The present study showed that canine rotation during retraction was significantly greater with the Geometry-X spring (34.5°) compared to the Segmental T-loop (15.4°). While the Segmental T-loop rotation aligns with previous reports of 17.2°–17.6° (Younes MAA et al.[19]; Nandan et al.[21]), the nearly twofold increase observed with Geometry-X raises concerns regarding its ability to control rotational movement. In comparison, other retraction systems, such as the modified Marcotte spring (2.4°; Davis et al.[20]) and PG spring (5.07°; Ziegler and Ingervall[14]), demonstrate substantially less rotation, suggesting superior rotational control. These differences likely reflect variations in spring design, force application points, and moment-to-force ratios. The high degree of rotation associated with Geometry-X highlights a potential clinical limitation, emphasizing the need for careful monitoring and adjunctive measures to manage canine rotation during retraction.

Distal crown tipping during canine retraction was slightly less with the Geometry-X spring (9.8°) compared to the Segmental T-loop (11.3°), indicating better control of tipping. However, both values were higher than those previously reported for the Segmental T-loop (7.50°–7.83°; Mehta and Sable[22]; Younes MAA et al.[19]) and for other retraction systems, such as the Ricketts maxillary canine retractor (7.89°; Hayashi et al.[23]) and the modified Marcotte spring (6.64°; Davis et al.[20]). These results suggest that while Geometry-X offers modest improvement over the Segmental T-loop, it produces greater distal crown tipping than certain alternative spring designs.

Anchorage loss during individual canine retraction was lower with the Geometry-X spring (1.75 mm) compared to the Segmental T-loop (2.65 mm), indicating that Geometry-X allows more efficient tooth movement while better preserving posterior anchorage. These findings suggest that the design and force system of Geometry-X may reduce reactive forces on the anchor unit, thereby minimizing unwanted mesial movement of posterior teeth. The values reported in this study are consistent with previous literature, with Nandan et al.[21] documenting 2.40 mm and Younes MAA et al.[19] reporting 1.88 mm of anchorage loss for Segmental T-loop mechanics.

When compared to other retraction systems, the modified Marcotte spring (0.79 mm; Davis et al.[20]) and the PG spring (0.59 mm; Ziegler and Ingervall[14]) have been shown to achieve substantially lower anchorage loss. Although Geometry-X does not match the anchorage preservation of these highly efficient systems, it nevertheless demonstrates superior performance relative to the Segmental T-loop, making it a clinically favorable option in cases where moderate anchorage conservation is required during individual canine retraction.

Overall, the findings of this study suggest that the Geometry-X spring offers several clinical advantages over the Segmental T-loop, including a slightly higher rate of canine retraction and reduced anchorage loss. These benefits, however, are offset by a significantly greater degree of canine rotation, highlighting a notable limitation in its clinical application. To mitigate this drawback, careful monitoring and the use of auxiliary rotational control strategies, such as ligatures or rotational stops, are recommended when employing the Geometry-X spring. In contrast, the Segmental T-loop continues to provide reliable control over canine rotation and distal crown tipping, making it a suitable option in cases where controlled bodily tooth movement is prioritized. Ultimately, the choice of retraction appliance should be individualized, taking into account the patient's anchorage requirements, treatment objectives, and the clinician's preference for balancing efficiency, anchorage preservation, and control of tooth movement.

A notable limitation of this study is the relatively small sample size, which may reduce the representativeness of the findings and limit the statistical power of the analysis. With fewer participants, there is an increased risk of random variability affecting the outcomes, potentially restricting the accuracy and generalizability of the results across different clinical settings. Additionally, the study specifically required participants to have bilaterally labially displaced canines, a strict inclusion criterion that further narrowed the pool of eligible subjects. This requirement excludes cases with unilateral labial displacement or other atypical canine positions, thereby limiting the external validity of the findings. Collectively, the combination of a small sample size and stringent inclusion criteria restrict the applicability of the results. Future studies with larger, more diverse samples and broader inclusion criteria are recommended to confirm and extend these findings.

CONCLUSION

The Geometry-X spring demonstrated enhanced efficiency in canine retraction while providing improved control over molar anchorage, distal crown tipping, and root resorption, resulting in more predictable and consistent clinical outcomes. This superior performance can be attributed to the appliance's design and biomechanics, which allow for precise and controlled force application. However, Geometry-X was associated with significantly greater rotational changes in canines compared to the Segmental T-loop, suggesting that it may offer a potential advantage in managing highly placed canines with pronounced distobuccal rotation. In addition to its mechanical benefits, Geometry-X has been reported to improve patient comfort and reduce clinician stress, as it eliminates the need for complex wire bending. Its streamlined design allows for smoother and less bulky appliance placement, minimizing irritation and discomfort commonly encountered with appliances such as the Segmental T-loop. These features may enhance patient compliance and contribute to a more favorable overall treatment experience.

REFERENCES

1. Thomas M. Orthodontics in the "Art" of Aesthetics. Int J Orthod Milwaukee. 2015;26(4):23-8.
2. Kulshrestha RS, Tandon R, Chandra P. Canine retraction: A systematic review of different methods used. J Orthod Sci. 2015;4(1):1-8.
3. Nahidh M, Yassir YA, McIntyr GT. Different methods of canine retraction-Part 1. J Bagh Coll Dent. 2022;34(3):58-74.
4. Cattaneo PM, Dalstra M, Melsen B. Moment-to-force ratio, center of rotation, and force level: a finite element study predicting their interdependency for simulated orthodontic loading regimens. Am J Orthod Dentofacial Orthop. 2008;133(5):681-9.

5. Li Y, Jacox LA, Little SH, Ko CC. Orthodontic tooth movement: The biology and clinical implications. Kaohsiung J Med Sci. 2018;34(4):207-214.
6. Ribeiro GL, Jacob HB. Understanding the basis of space closure in Orthodontics for a more efficient orthodontic treatment. Dental Press J Orthod. 2016;21(2):115 25.
7. McLaughlin RP, Kalha AS, Schuetz W. An alternative method of space closure: the Hycon Device. J Clin Orthod. 2005;39(8):474-84.
8. Sharma R, Mittal AK, Sidana A, Tiwari P. Canine retraction in orthodontics: A review of various methods. Med Res Chron. 2015;2(1):83-93.
9. Bokas J, Woods M. A clinical comparison between nickel titanium springs and elastomeric chains. Aust Orthod J. 2006;22(1):39-46.
10. Kojima Y, Fukui H. Numeric simulations of en-masse space closure with sliding mechanics. Am J Orthod Dentofacial Orthop. 2010;138(6):702.e1-6; discussion 702-4.
11. Mezomo M, de Lima ES, de Menezes LM, Weissheimer A, Allgayer S. Maxillary canine retraction with self-ligating and conventional brackets. Angle Orthod. 2011;81(2):292-7.
12. Kuhlberg AJ, Burstone CJ. T-loop position and anchorage control. Am J Orthod Dentofacial Orthop. 1997;112(1):12-8.
13. Viecilli AF, Freitas MPM. The T-loop in details. Dental Press J Orthod. 2018;23(1):108-117.
14. Ziegler P, Ingervall B. A clinical study of maxillary canine retraction with a retraction spring and with sliding mechanics. Am J Orthod Dentofacial Orthop. 1989;95(2):99-106.
15. Proffit WR, Fields HW Jr. Contemporary orthodontics. 3rd ed. St Louis, Mo: CV Mosby; 2000:348.
16. Roth RH. Treatment mechanics for the straight wire appliance. In: Graber TM, Vanarssall RL, eds. Orthodontics, Current Principles and Techniques. 2nd ed. St Louis, Mo: CV Mosby; 1994:685–711.
17. Kuhlberg AJ. Steps in orthodontic treatment. In: Bishara SE, ed. Textbook of Orthodontics. Philadelphia, Pa: WB Saunders; 2001:240–242.
18. Keng FY, Quick AN, Swain MV, Herbison P. A comparison of space closure rates between preactivated nickel-titanium and titanium-molybdenum alloy T-loops: a randomized controlled clinical trial. Eur J Orthod. 2012;34(1):33-8.
19. Younes MAA, Albelasy NF, Fouda AM. Comparative evaluation of the efficiency of segmental maxillary canine retraction using Burstone T-loops versus elastomeric chains: a split-mouth randomized clinical trial. Dental Press J Orthod. 2025;30(2):e2524233.
20. Davis S, Sundareswaran S, James J. Comparative evaluation of the efficiency of canine retraction using modified Marcotte and T-loop retraction springs: A split mouth, randomized clinical trial. J Orthod Sci. 2019;8:9.
21. Nandan H, Kumar CS, Jha P. Comparison of Maxillary Canine Retraction Using Split-Mouth Design With Dual Force Cuspid Retractor and T-loop Segmental Arch: A Split-Mouth Randomized Clinical Trial. Cureus. 2023;15(2):e35288.
22. Mehta KR, Sable RB. Comparison of the Amount of Maxillary Canine Retraction, with T-Loops, using TMA and Stainless Steel Wires: A Clinical Study. J Ind Orthod Soc 2013;47(4):178-183.
23. Hayashi K, Uechi J, Murata M, Mizoguchi I. Comparison of maxillary canine retraction with sliding mechanics and a retraction spring: a three-dimensional analysis based on a midpalatal orthodontic implant. Eur J Orthod. 2004;26(6):585-9.