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Comparison of the Effects of Labial and Lingual Retraction of Canines Using Sliding Mechanics: an In-vivo Study

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Abstract

Aim: The purpose of this study was to compare labial and lingual forces of the rate of canine retraction and three dimensional control of the molar and canine using sliding mechanics.
Methods: Ten patients with Angle's class I malocclusion with bimaxillary protrusion referred for first premolar extraction enrolled in this split mouth study. Forty canines were placed into four groups according to the arch and type of force: UB (upper canine–labial force), LB (lower canine–labial force), UL (upper canine–lingual force), and LL (lower canine–lingual force). The rate of retraction of the canine, molar and canine rotation, molar and canine angulation, and molar anchorage loss in the sagittal and vertical plane was assessed using study models and orthopantomographs (OPG). The paired and unpaired t tests were used for intra and inter group comparison. The significance level was 0.05.
Results: The rate of canine retraction was significantly faster for labial forces than lingual forces using sliding mechanics ($P<0.001$). However, significantly greater amount of molar rotation was observed using lingual forces ($P<0.001$). There was no significant difference regarding canine rotation using labial forces ($P<0.05$). The molar anchorage loss in the sagittal plane was significantly lesser using lingual forces ($P<0.001$).
Conclusion: Canine retraction was faster when labial forces were applied using sliding mechanics whereas 3D-molar control was better when lingual forces were applied, which is advantageous for critical anchorage cases.

Keywords: Canine retraction, labial forces, lingual forces, sliding mechanics

1. Background

Extraction therapy is generally recommended to redress extreme crowding, retract the anterior teeth, redress molar mal-relationships, and camouflage the facial profile. Among the different space closure options that are available today, sliding mechanics for anterior retraction has become quite favored mainly after the development of the MBT treatment philosophy. In sliding mechanics, the space closure is usually done with either active tiebacks, e-chains, or NiTi closing springs (1). In Sliding mechanism, the size and properties of the archwire used for retracting anterior teeth with a light and continuous force, helps in minimizing friction and loss of molar anchorage (2).

Lingual appliances offer biomechanical advantages over labial appliances as the point of application of force is closer to the center of resistance of the tooth (3). Retraction of canines represents a fundamental stage in a considerable number of cases especially with severe crowding or proclination of anterior teeth when anchorage is critical. The position of canines after retraction has been recognized to be of prime importance for functional stability and aesthetics.[4]

It is always desirable to distalize canines bodily without tipping. Scant literature exists regarding the comparison of labial against lingual forces for canine retraction using sliding mechanics. Hence, this study aimed to compare the efficiency of labial and lingual forces for the rate of retraction of the canine using sliding mechanics and determine three dimensional (3D) controls of the canine and molar.

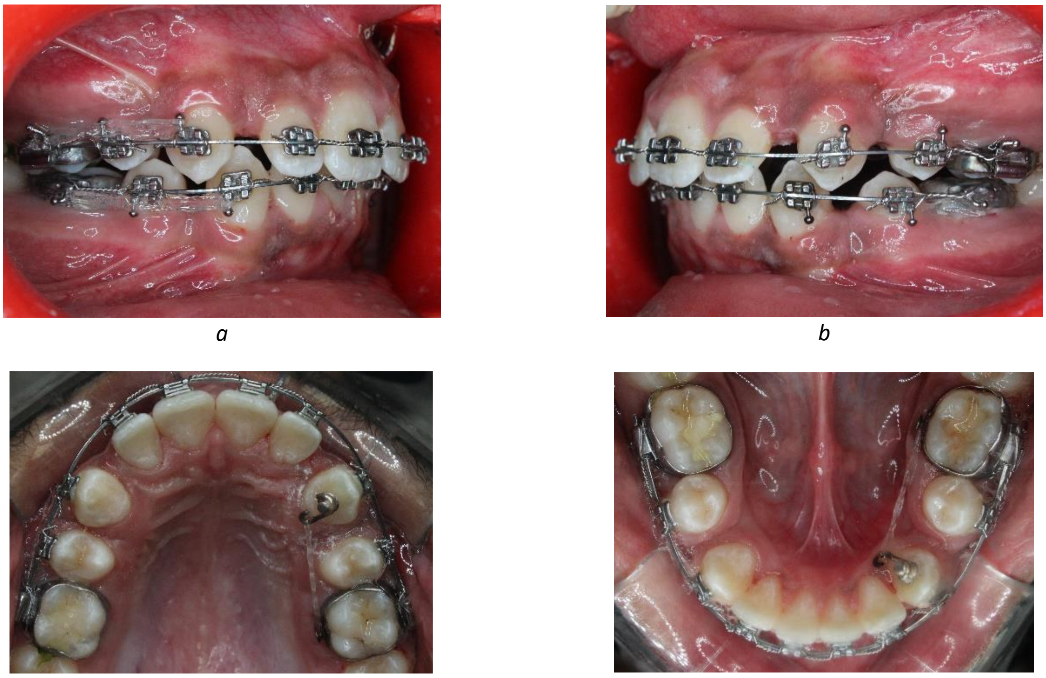
2. Methods

Ten patients aged 12 - 25 years old with class I malocclusion and bimaxillary protrusion were randomly selected for this study. Before commencement of the study, an ethical clearance was obtained from the Institutional Ethics Committee of the College. Patients indicated for first premolar extractions with minimal or no crowding and canines in the same position with respect to the midline were included in this study. Patients with ectopic canines, craniofacial anomalies and those medically compromised were excluded from this study.

Photographs, OPG, and study models were recorded (T0) and all four first premolars were extracted. 0.022” slot MBT brackets were bonded (Basic Series, Koden Inc., Newington, CT, USA). After initial leveling and aligning, photographs, OPG, and study models were recorded again (T1) and 0.017” x 0.025” stainless steel archwires (Koden Inc., Newington, CT, USA) were placed.

A split mouth study was designed and patients were randomly separated into two groups. Forty canines were placed into four groups according to the arch and type of force: UB (upper canine–labial force), LB (lower canine–labial force), UL (upper canine–lingual force), and LL (lower canine–lingual force). In group I, on the right side, five maxillary (UB) and five mandibular (LB) canines were retracted using labial force, and on the left side, five maxillary (UL) and five mandibular (LL) canines were retracted using lingual force. In group II, on the right side, five maxillary (UL) and five mandibular (LL) canines were retracted using lingual force, and on the left side, five maxillary (UB) and five mandibular (LB) canines were retracted using labial force.

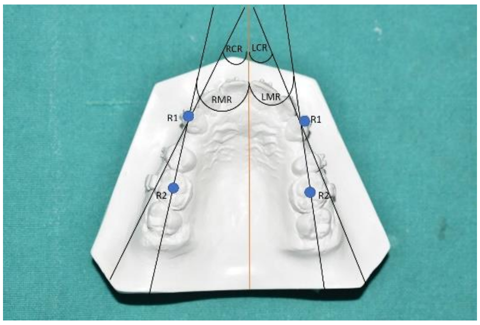
For canine retraction by labial force, the elastomeric chain was engaged from the hook of the first permanent molar to the hook of the canine bracket. For canine retraction by lingual force, the Dyna-Link elastomeric chain (G&H Orthodontics, Franklin, Indiana St at e, USA) was engaged from the lingual button with the hook of the first permanent molar to the lingual button with the hook on the canine (Fig. 1). The elastomeric chain delivered an initial force of 300 grams as measured with the help of a Dontrix gauge dynamometer (Leone Spa, Firenze, Italy). Patients were recalled every four weeks for six months. Photographs, OPG, and study models were recorded again (T2).



a b c d

Figure 1a-d. Intraoral photographs of a patient showing canine retraction mechanics

Figure 2. Measurement of rate of retraction of the canine calculated on the study model by dividing the distance between A-B (A: the distal contact point of the canine, B: the mesial contact point of the second premolar) by the total time taken.



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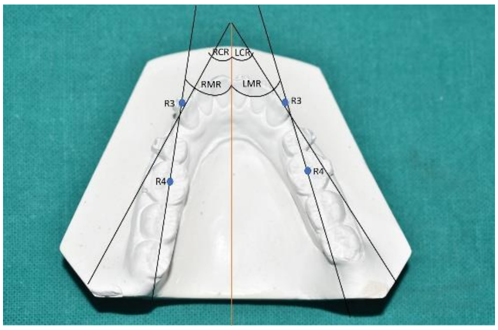

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Figure 3a and b. Measurements of canine and molar rotation on the study models: R1 - Reference point 1 - Cusp tip of the maxillary canine; R2 - Reference point 2 - Central fossa of the first permanent maxillay molar; LCR, RCR - Maxillary left and right canine rotation; LMR, RMR - Maxillary left and right molar rotation; R3 - Reference point 3 - Cusp tip of the mandibular canine; R4 - Reference point 4 - Central fossa of the first permanent mandibular molar; LCR, RCR - Mandibular left and right canine rotation; LMR, RMR - Mandibular left and right molar rotation.

The rate of canine retraction was computed as the amount of canine retracted, divided by the time required on the study models at T2 (Fig. 2). Rotational changes of canines and molars were also measured from the study models photographed with the central projection perpendicular to the occlusal plane at T1 and T2 (Fig. 3) (5). Angulation of canines and molars and molar anchorage loss in the sagittal and vertical plane was measured on the OPG and recorded at T1 and T2 (Fig. 4 and 5).

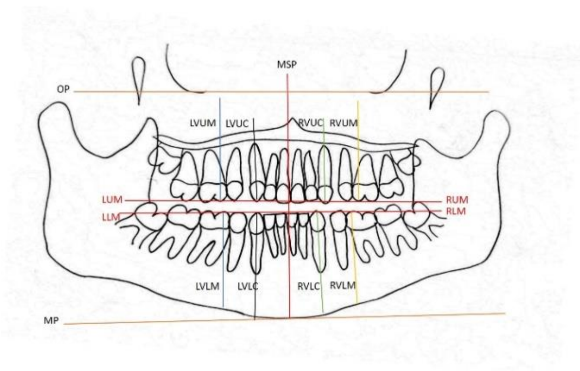

Figure 4. Measurements of sagittal and vertical anchorage loss on the OPG: MSP - Mid sagittal plane; OP - Orbital plane; MP - Mandibular plane; a) LUM, RUM – Anchorage loss of the maxillary left and right first molar in the sagittal plane; b) LLM, RLM - Anchorage loss of the mandibular left and right first molar in the sagittal plane; c) LVUM, RVUM – Anchorage loss of the maxillary left and right first molar in the vertical plane; d) LVLM,RVLM – Anchorage loss of the left and right mandibular first molar in the vertical plane; e) LVUC, RVUC - Vertical control of the left and right maxillary canine; f) LVLC, RVLC - Vertical control of the left and right mandibular canine.

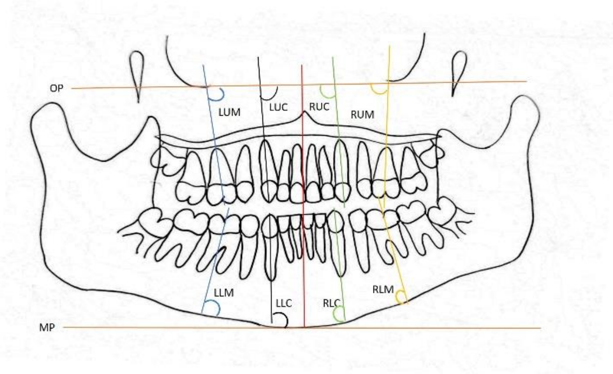

Figure 5. Measurements of the molar and canine angulation on the OPG: a) LUC, RUC - Maxillary left and right canine angulation; b) LLC, RLC - Mandiblar left and right canine angulation; c) LUM, RUM - Maxillary left and right molar angulation; d) LLM, RLM- Mandibular left and right molar angulation.

Statistical Analysis

The paired and unpaired t tests were used for intra and inter group comparison. The level of significance was set at 0.05. The measurements were repeated in five patients after an interval of two weeks and the intra-examiner error was calculated using Cohen's kappa statistics.

3. Results

Table 1 shows the rate of canine retraction in the maxillary and mandibular arch. The canine retraction was significantly faster using labial force in both arches (P=0.001). Table 2 shows 3D control of the molar. A statistically significant difference (P<0.05) existed for molar angulation, molar rotation, molar anchorage loss in the vertical and sagittal plane except for molar rotation and molar anchorage loss in the vertical plane in the UB group for pre-and post-retraction values.

Table 1. Rate of canine retraction in mm/month

Group	N	Mean ± SD	P
UB	10	1.26 ± 0.17	.001*
UL	10	0.89 ± 0.19	
LB	10	1.13 ± 0.09	.001*
LL	10	0.82 ± 0.11	

UB: Upper Buccal, UL: Upper Lingual, LB: Lower Buccal, LL: Lower Lingual, *P<.001=highly significant difference

Table 3 shows intergroup analysis for 3D control of the molar. A statistically significant difference

Table 2. 3D Molar Control

Parameters	Groups	N	Pre-retraction Mean ± SD	Post-retraction Mean ± SD	Mean difference	P
Molar angulation (in degrees)	UB	10	84.58 ± 4.30	82.00 ± 4.86	2.58 ± 1.97	.001**
	UL	10	84.33 ± 3.47	82.67 ± 3.14	1.67 ± 0.88	.001**
	LB	10	78.75 ± 8.57	74.83 ± 8.63	3.91 ± 1.72	.001**
	LL	10	77.08 ± 7.07	75.83 ± 6.74	1.25 ± 1.21	.004*
Molar rotation (in degrees)	UB	10	8.00 ± 2.79	7.00 ± 4.16	1.00 ± 2.59	.209
	UL	10	10.25 ± 3.29	6.29 ± 3.55	3.95 ± 2.97	.001**
	LB	10	12.25 ± 3.63	10.08 ± 3.72	2.16 ± 0.83	.001**
	LL	10	12.95 ± 2.57	7.71 ± 1.86	5.25 ± 1.27	.001**
Molar anchorage loss in vertical plane (in mms)	UB	10	46.5 ± 2.75	46.45 ± 2.99	0.04 ± 0.62	.820
	UL	10	46.29 ± 2.36	45.83 ± 2.17	0.45 ± 0.39	.002*
	LB	10	45.79 ± 2.14	45.54 ± 2.02	0.25 ± 0.33	.026*
	LL	10	46.29 ± 2.35	45.75 ± 2.26	0.54 ± 0.39	.001**
Molar anchorage loss in sagittal plane (in mms)	UB	10	54.83 ± 5.20	53.54 ± 5.39	1.29 ± 0.45	.001**
	UL	10	55.75 ± 7.53	55.16 ± 7.64	0.58 ± 0.36	.001**
	LB	10	55.91 ± 5.96	53.54 ± 5.70	2.37 ± 1.11	.001**
	LL	10	58.25 ± 4.95	57.91 ± 5.12	0.33 ± 0.44	.025*

UB: Upper Buccal, UL: Upper Lingual, LB: Lower Buccal, LL: Lower Lingual, P>.05: not significant difference, *P<.05: significant difference, **P<.001: highly significant difference

Table 3. Intergroup analysis for 3D molar control

Parameters	Groups	Mean difference	P
Molar angulation (in degrees)	UB x UL	0.916	.157
	LB x LL	2.66	.001**
	UB x LB	-1.33	.092
	UL x LL	0.41	.348
Molar rotation (in degrees)	UB x UL	-2.95	.016*
	LB x LL	-3.08	.001**
	UB x LB	-1.17	.152
	UL x LL	-1.29	.180
Molar anchorage loss in vertical plane (in mms)	UB x UL	-0.42	.063
	LB x LL	-0.29	.065
	UB x LB	-0.21	.318
	UL x LL	-0.08	.612
Molar anchorage loss in sagittal plane (in mms)	UB x UL	0.71	.001**
	LB x LL	1.31	.001**
	UB x LB	-1.08	.005*
	UL x LL	0.25	.143

UB: Upper Buccal, UL: Upper Lingual, LB: Lower Buccal, LL: Lower Lingual, P>.05: not significant difference, *P<.05: significant difference, **P<.001: highly significant difference

(P<0.05) existed in relation to molar angulation between the LB and LL group. A statistically significant difference (P<0.05) existed in molar rotation between the UB and UL group as well as the LB and LL group. A statistically significant difference (P<0.05) existed in molar anchorage loss in the sagittal plane between all the segments except the UL and LL group.

Table 4 shows 3D control of canines. A statistically significant difference (P<0.05) existed for canine angulation in LB and LL group and for canine rotation in UB, LB and LL group for pre and post-retraction values.

Table 5 shows intergroup analysis for 3D control of canines. A statistically significant difference (P<0.05) existed in relation to canine angulation between UL and LL group and for canine rotation between UB and UL; and LB and LL group.

The intra-examiner error was low as the value of the Cohen's kappa statistics for the two sets of readings was 0.89, suggesting excellent agreement.

Table 4. 3D canine control

Parameters	Groups	N	Pre retraction Mean ± SD	Post retraction Mean ± SD	Mean Difference	P
Canine angulation (in degrees)	UB	10	88.17±2.86	88.67±7.02	-0.5 ± 6.73	.802
	UL	10	85.08±4.54	84.83±5.67	0.25 ±4.65	.856
	LB	10	80.75±4.99	77.58±4.69	3.16 ±2.72	.002*
	LL	10	84.58±5.33	79.92±4.64	4.66 ±1.23	.001**
Canine rotation (in degrees)	UB	10	34.13±2.76	27.42±4.78	6.71 ± 3.06	.001**
	UL	10	36.67±3.01	35.21±3.20	1.46±4.01	.234
	LB	10	36.79±4.89	32.08±3.44	4.70 ±2.66	.001**
	LL	10	40.29±4.15	37.54±3.64	2.75 ±1.87	.001**
Vertical control of canine (in mms)	UB	10	47.91±2.64	47.31±2.71	0.6 ± 1.65	.233
	UL	10	47.16±4.10	46.8±4.35	0.36±0.76	.125
	LB	10	45.45±2.03	45.00±1.99	0.45 ±0.33	.053
	LL	10	45.87±3.29	45.62±3.35	0.25 ±0.39	.053

UB: Upper Buccal, UL: Upper Lingual, LB: Lower Buccal, LL: Lower Lingual, P>.05: not significant difference, *P<.05: significant difference, **P<.001: highly significant difference

Table 5. Inter-group analysis for 3D canine control

Parameters	Groups	N	Mean difference	P
Canine angulation (in degrees)	UB x UL	10	-0.75	.754
	LB x LL	10	-1.5	.096
	UB x LB	10	-3.67	.094
	UL x LL	10	-4.41	.004*
Canine rotation (in degrees)	UB x UL	10	5.25	.002*
	LB x LL	10	1.95	.049*
	UB x LB	10	2.00	.102
	UL x LL	10	-1.29	.324
Vertical control of canine (in mms)	UB x UL	10	0.23	.660
	LB x LL	10	0.28	.179
	UB x LB	10	0.14	.773
	UL x LL	10	0.12	.644

UB: Upper Buccal, UL: Upper Lingual, LB: Lower Buccal, LL: Lower Lingual, *P<.05: significant difference

4. Discussion

Precise forecast of the amount of anchorage loss amidst space closure is essential to establish the treatment module and choose the appropriate mechanics. Separate canine retraction for maximum anchorage has been recommended by many researchers (5-7). If canine retraction is carried out with no simultaneous tipping or rotation, the subsequent treatment plan will be facilitated and the treatment period can be shortened (8). Traditionally the canines are retracted by the application of retraction forces from the labial side (6-8). The present study compared retraction of canines by forces being applied from the labial as well as the lingual aspect with a labial appliance in place using the split mouth study in the same patient in both maxillary and mandibular arches.

Lingual appliances offer better anchorage on the lower posterior teeth than labial appliances due to the different point of force application. The anchorage value of the posterior teeth in the sagittal and vertical directions appear to be higher in lingual orthodontics than in labial orthodontics (9).

In present study, labial forces showed greater rate of retraction of canines as compared to the lingual force. The rate of retraction of maxillary canines when buccal force was applied (1.26 mm/month) was also similar to other studies by Soni et al.[10], Ziegler and Ingervall (11), and Bokas and Woods (12).

However, the lingual technique was superior in the anchorage preservation of molars in the sagittal plane. In present study, the anchorage loss was 1.29±0.45 mm for labial force and 0.58±0.36 mm for lingual force, which was less than the studies by Agrawal et al. (13) and Bhat et al. (14). Geron et al. (15) also showed greater loss of anchorage with labial appliances than lingual appliances.

The present study showed an increased molar rotation for lingual force application. Molars have a tendency for distal rotation in lingual orthodontics that requires compensatory bends in the archwires (9). In present study, archwires were placed on labial aspects without any compensatory bends to prevent this shortcoming.

The present study showed a statistically significant difference in canine rotations in both arches. The reason for the small amount of change in canine rotation is that the application of force on the lingual aspect is comparatively nearer to the center of resistance of the canines (3).

Further comparative studies are required with a larger sample size and 3D imaging technique to determine the efficiency of labial and lingual appliances in canine retraction.

Conclusion

Faster canine retraction, greater degree of canine rotation, and greater anchorage loss was found when labial forces were applied in both arches, whereas there was greater degree of molar rotation using lingual forces in both arches.

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