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SOFT TISSUE CHANGES FOLLOWING ANTERIOR TEETH RETRACTION USING THREE DIFFERENT TECHNIQUES: A RETROSPECTIVE STUDY

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ABSTRACT

Objective: This study aims to evaluate the soft tissue changes resulting from first premolar extraction and anterior teeth retraction using en-masse retraction compared to two-step retraction.

Materials and Methods: The study included a total sample size of 36 adult patients divided equally into three groups, with 12 patients in each group. Group 1 was treated using en-masse retraction on a 0.019" × 0.025" stainless steel archwire. Group 2 received en-masse retraction on a 0.017" × 0.025" stainless steel archwire, while Group 3 underwent two-step retraction using a 0.017" × 0.025" stainless steel archwire.

Results: Both Group 2 and Group 3 exhibited statistically significant changes compared to Group 1 in terms of lower lip retraction and reduction in incisal show. The lower lip retraction measurements were 1.72 mm ±3.30mm, 2.58mm ±4.82 mm, and 4.13 mm ± 2.72 mm for Groups 1, 2, and 3, respectively. The decrease in incisor display was 0.06 mm ± 0.87mm, 1.38mm ±1.99mm, and 1.42 mm±1.39 mm, respectively.

Conclusion: The en-masse retraction technique, particularly with thinner archwire, and the two-step retraction technique resulted in increased retroclination of the upper and lower incisors, reduced upper incisor display, and greater retraction of the lower lip.

KEYWORDS: anterior teeth retraction, soft tissue change, esthetics.

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INTRODUCTION

The primary objective of orthodontic treatment for the majority of patients is to enhance the appearance of their teeth and face. Consequently, the aim of orthodontic treatment should be to enhance the attractiveness of the patient's dental and facial features. One common concern related to facial aesthetics is the protrusion of the lips, which can be observed in cases of Class II Division I malocclusion as well as bimaxillary dentoalveolar protrusion.[1] Typically, individuals with a protruded facial profile are perceived as less socially appealing compared to those with a normal soft tissue appearance or a straight profile, which can impact their psychological and social well-being.[2]

These patients seek orthodontic treatment to reduce the protrusion of their lips and improve their facial profile. The most frequently employed treatment plan involves extracting the first four premolars to create sufficient space for retracting the anterior segment. This approach aims to decrease overall lip protrusion and enhance the patient's profile.[3-6] However, the method of retracting the anterior teeth may vary depending on the technique used. Traditionally, two techniques are commonly used to achieve complete retraction: the two-step technique and the en-masse retraction technique. In the two-step technique, the canines are retracted first, followed by the retraction of the four anterior teeth. Conversely, the en-masse retraction technique involves retracting the anterior segment as a single unit.[7]

Both techniques are effective for closing the space created by the extracted first premolar. However, when it comes to aesthetics, there is still a debate regarding which technique produces a better smile frame and facial profile, particularly after retraction.[8-11] Therefore, there remains a query as to which retraction technique yields superior outcomes in terms of anteroposterior and vertical changes in soft tissue aesthetics.

OBJECTIVES OF THE STUDY

To evaluate the resultant soft tissue changes after 1st premolars extraction and anterior teeth retraction using different retraction techniques. The null hypothesis was that there was no soft tissue changes difference between en-masse retraction and two-step technique.

MATERIALS AND METHODS

Trial design

This study was approved by the Research Ethics Committee of the Faculty of Dentistry, Cairo University. The sample was collected retrospectively from the records of patients who were successfully treated at the department of Orthodontics, Faculty of Dentistry, Cairo University. The recruited records include Pre & post- treatment lateral cephalometric radiographs of: post-pubertal female patients with an age range between 18-40 years old, having maxillary dento-alveolar protrusion with minimum crowding and who were treated by extraction of 1st premolars using mini-screws to provide absolute anchorage. Patients treated with different extraction patterns or different mechanics were excluded so those with a history of any oral habit.

The total sample size was 36 patients divided equally into three groups 12 patients each; Group 1 patients were treated using en-masse retraction on 0.019" × 0.025" stainless steel archwire. Group 2 were treated using en-masse retraction on 0.017" × 0.025" stainless steel archwire while Group 3 were treated using two-step retraction on 0.017" × 0.025" stainless steel archwire (Figure 1). In all three groups, brackets slot 0.022 inch (Mini-master, American Orthodontics, Sheboygan, Wis, USA) were used. Leveling and alignment was done till the desired wire used for retraction was reached. After which the upper first premolars were extracted and two miniscrews (Absoanchor, SH1312-07, Dentos Co, Ltd, Daegu, Korea) 1.6 mm in diameter and 8 mm in length were placed between the upper first molar and the second premolar bilaterally. In Groups 1 and 2, a power hook was crimped on the

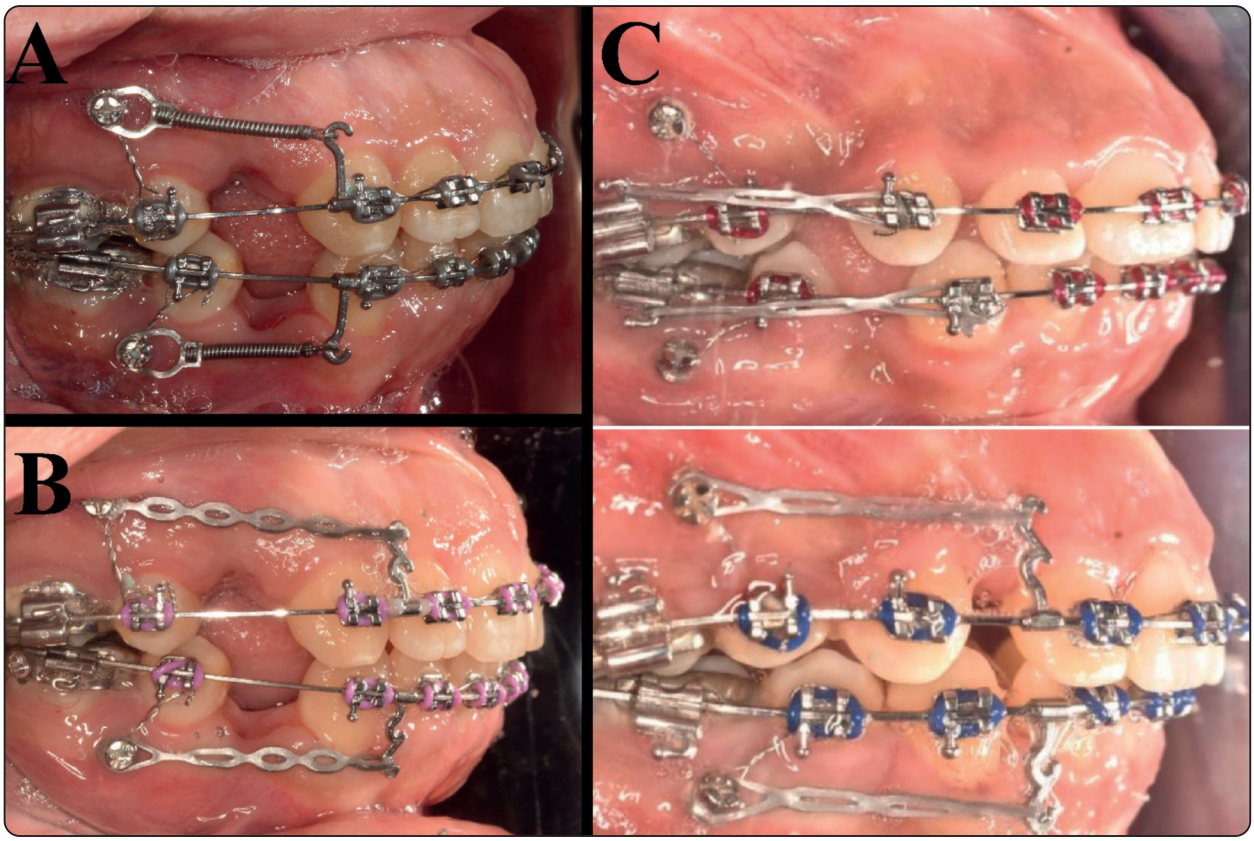

Fig. (1) A: en-masse retraction on 0.019" × 0.025" stainless steel archwire. B: en-masse retraction on 0.017" × 0.025" stainless steel archwire. C: two-step retraction on 0.017" × 0.025" stainless steel archwire.

archwire bilaterally. A power chain, changed every three weeks, was placed between the miniscrew and the hook to retract the anterior segment. While in Group 3, stainless steel ligature was used to tie the upper second premolar to the miniscrew to provide indirect anchorage. The upper canine was first retracted using a power chain to the upper first molar after which retraction of the upper incisors was done.

Cephalometric Analysis

Lateral cephalometric radiographs were taken in maximum intercuspal occlusion using Planmeca Proline XC dental x-ray unit. WebCeph (WebCeph, AssembleCircle Corp, Korea) (www.webceph.com) was used to trace the pre and post treatment lateral cephalograms to evaluate the treatment changes. Fifteen lateral cephalograms were randomly selected and traced again by the principal investigator at a 2-week interval to assess the intra-observer reliability. The same fifteen cephalograms were measured by another investigator to assess inter-observer reliability.

Statistical Analysis

Statistical analysis was performed with SPSS 20 (Statistical Package for Social Science, IBM, USA), Graph Pad Prism (Graph Pad Technologies, USA) and Microsoft Excel 2016 (Microsoft Co-operation, USA). All data were explored for normality by using Shapiro Wilk and Kolmogorov Normality test and presented as means and standard deviation values. Comparison between pre and post was performed by using Paired t test. Comparison between 3 different groups was performed by using One Way ANOVA test followed by Tukey`s Post Hoc test for multiple comparison. Significance level was set at the level of $p \leq 0.05$.

RESULTS

In Group 1, regarding the skeletal changes, there was no statistically significant change in any of the variables. However, there was a statistically significant decrease in the amount of upper incisor inclination; the upper incisors retroclined by 8.19° ± 5.56° and by 7.88° ± 4.09° relative to Frankfort Horizontal and SN planes respectively. There was no statistically significant change regarding the lower incisor inclination, however there was a statistically significant linear lingual displacement of lower incisor edge by 1.95 mm ± 2.51 mm. This led to a statistically significant decrease in the amount of lower lip protrusion in relation to E-plane by 1.72 mm ± 3.30 mm with no statistically significant change regarding the upper lip position. Finally, there was a statistically significant decrease in the interlabial gap by 0.94 mm ± 0.68 mm.

In Group 2, there was no statistically significant change in any of the skeletal variables. There was a statistically significant decrease in the amount of upper incisor inclination; the upper incisors retroclined by 15.96°±7.87° and by 15.47°± 7.99° relative to Frankfort Horizontal and SN planes

TABLE (1) Mean, standard deviation (SD) values and results of paired t-test and for the changes after treatment in Group 1.

Variable	Pre		Post		Change				
	M	SD	M	SD	MD	SD	95% CI		P value
							L	U	
SNA	86.38	4.43	85.25	3.79	-1.12	2.52	-2.08	4.33	0.477
SNB	79.40	5.32	78.48	4.92	-0.92	2.60	-3.06	4.90	0.639
ANB	6.97	3.18	6.77	2.41	-0.20	1.98	-1.99	2.39	0.851
FMA	25.58	5.76	25.59	6.33	0.00	2.73	-4.71	4.70	0.999
Wits appraisal	1.44	3.15	1.78	2.28	0.34	2.75	-2.48	1.79	0.745
Overjet	2.87	1.15	2.56	0.91	-0.31	1.17	-0.50	1.11	0.437
Overbite	2.31	0.89	2.84	0.73	0.53	0.94	-1.16	0.10	0.098
U1 to FH	115.73	7.52	107.54	7.72	-8.19	5.56	2.27	14.11	0.009
U1 to SN	106.19	7.95	98.32	8.03	-7.88	4.09	1.67	14.08	0.015
IMPA	100.96	7.82	96.87	8.29	-4.09	6.46	-2.17	10.35	0.191
Interincisal angle	117.72	8.32	130.00	8.16	12.28	7.96	-18.68	-5.88	0.001
U1 to NA(mm)	3.33	2.84	1.82	1.10	-1.51	2.58	-0.16	3.18	0.075
L1 to NB(mm)	7.87	2.39	5.92	1.95	-1.95	2.51	0.25	3.65	0.026
Upper incisal display	3.84	0.97	3.90	1.18	0.06	0.87	-0.90	0.78	0.891
Upper lip to E-plane	0.93	1.80	-0.28	1.49	-1.21	2.65	-0.08	2.49	0.064
Lower lip to E-plane	3.58	1.83	1.86	2.45	-1.72	3.30	0.04	3.40	0.045
Nasolabial angle	92.39	8.30	99.50	12.88	7.11	17.00	-15.53	1.31	0.094
Labiomental angle	135.82	14.38	132.29	16.93	-3.53	16.44	-8.68	15.74	0.557
Interlabial gap	2.09	0.69	1.15	0.62	-0.94	0.68	0.43	1.45	0.001

**: Significant at P ≤ 0.05*

respectively. The lower incisors were also retroclined by a statistically significant 12.22°±8.75° relative to the mandible plane. This led to a statistically significant retraction of the upper and lower lips relative to E-plane by 2.63mm ±3.30 mm and 2.58mm ±4.82 mm respectively. Furthermore, there was a statistically significant decrease in the amount of upper incisor display by 1.38 mm ± 1.99 mm. In addition, there was a statistically significant increase in the nasolabial angle by 16.83°±9.19°. Finally, there was a statistically significant decrease in the interlabial gap by 0.98mm ±1.07 mm.

In Group 3, there was no statistically significant change in any of the skeletal variables. There was a statistically significant decrease in the amount of upper incisor inclination; the upper incisors retroclined by 15.97° ±9.08° and by 15.53° ±.89° relative to Frankfort Horizontal and SN planes respectively. The lower incisors were also retroclined by a statistically significant 12.65° ±5.08° relative to the mandible plane. This led to a statistically significant retraction of the upper and lower lips relative to E-plane by 2.17 mm ±1.79 mm and 4.13mm ±2.72 mm respectively. Furthermore,

TABLE (2) Mean, standard deviation (SD) values and results of paired t-test and for the changes after treatment in Group 2.

Variable	Pre		Post		Change				
	M	SD	M	SD	MD	SD	95% CI		P value
							L	U	
SNA	83.31	3.55	83.29	2.67	-.02	2.11	-2.64	2.68	0.989
SNB	76.57	3.79	76.26	3.49	-.31	2.12	-2.78	3.39	0.839
ANB	6.75	2.11	7.03	2.72	.29	1.32	-2.35	1.77	0.776
FMA	31.72	4.24	31.10	4.86	-.62	2.02	-3.25	4.48	0.744
Wits appraisal	2.56	2.41	2.36	2.44	-.20	1.91	-1.86	2.25	0.843
Overjet	5.68	1.94	3.65	1.07	-2.03	2.27	0.70	3.36	0.004
Overbite	1.80	1.27	1.61	1.23	-.20	1.74	-0.86	1.25	0.705
U1 to FH	120.48	7.63	104.52	6.41	-15.96	7.87	9.99	21.93	0.001
U1 to SN	110.91	8.22	95.44	6.38	-15.47	7.99	9.24	21.70	0.001
IMPA	100.63	5.05	88.41	9.19	-12.22	8.72	5.94	18.50	0.001
Interincisal angle	107.17	6.97	135.97	8.45	28.79	10.29	-35.35	-22.23	0.001
U1 to NA(mm)	6.95	2.64	1.50	1.38	-5.45	2.77	3.67	7.23	0.001
L1 to NB(mm)	11.05	2.13	5.37	2.64	-5.68	2.80	3.65	7.72	0.001
Upper incisal display	4.82	1.47	3.44	1.30	-1.38	1.99	0.20	2.56	0.024
Upper lip to E-plane	2.20	2.27	-1.10	2.63	-3.30	2.03	1.22	5.38	0.003
Lower lip to E-plane	5.19	2.65	.38	2.58	-4.82	1.90	2.60	7.03	0.001
Nasolabial angle	92.18	11.80	109.00	14.16	16.83	9.19	-27.86	-5.79	0.005
Labiomental angle	149.93	10.85	141.68	18.13	-8.25	14.56	-4.40	20.90	0.190
Interlabial gap	2.82	1.24	1.84	.68	-.98	1.07	0.13	1.83	0.025

**: Significant at P ≤ 0.05*

there was a statistically significant decrease in the amount of upper incisor display by 1.42 mm ± 1.39 mm. In addition, there was a statistically significant increase in the nasolabial angle by 11.17° ± 10.60°. Finally, there was a statistically significant decrease in the interlabial gap by 1.96 mm ± 1.78 mm.

As for the differences between the three groups, Group 2 and 3 showed statistically significant differences in regard to upper and lower incisor inclination as well as the amount of retraction of the lower lip and decrease in the amount of incisal show. Tables 1 through 4 show the changes after treatment within each group and compared together.

Error of the method

Cronbach's alpha reliability coefficient and Intra-class Correlation Coefficient (ICC) were used and the range of values was more than 0.7 indicating a very good inter and intra-observer agreement.

TABLE (3) Mean, standard deviation (SD) values and results of paired t-test and for the changes after treatment in Group 3.

Variable	Pre		Post		Change				
	M	SD	M	SD	MD	SD	95% CI		P value
							L	U	
SNA	82.20	3.20	82.45	2.96	0.25	2.12	-2.86	2.36	0.846
SNB	75.61	3.32	75.33	3.20	-0.28	1.76	-2.48	3.04	0.836
ANB	6.59	1.14	7.12	1.95	0.53	1.33	-1.88	0.82	0.427
FMA	30.45	4.53	30.67	4.81	0.22	2.47	-4.18	3.73	0.908
Wits appraisal	2.02	1.93	1.74	2.48	-0.28	1.97	-1.60	2.16	0.762
Overjet	4.07	1.49	3.08	1.51	-0.99	2.32	-0.28	2.26	0.120
Overbite	1.23	1.14	1.93	1.07	0.70	1.02	-1.64	0.23	0.132
U1 to FH	120.44	5.31	104.47	5.49	-15.97	9.08	11.40	20.55	0.000
U1 to SN	108.82	6.25	93.28	4.92	-15.53	8.89	10.77	20.29	0.000
IMPA	103.91	4.15	91.27	3.95	-12.65	5.08	9.21	16.08	0.000
Interincisal angle	105.20	6.08	133.60	6.88	28.40	11.05	-33.89	-22.90	0.000
U1 to NA(mm)	6.70	2.76	1.35	0.96	-5.34	2.21	3.60	7.09	0.000
L1 to NB(mm)	11.34	2.42	6.30	2.27	-5.05	3.27	3.06	7.03	0.000
Upper incisal display	4.75	1.65	3.34	1.28	-1.42	1.39	0.17	2.67	0.028
Upper lip to E-plane	1.92	2.32	-0.25	1.97	-2.17	1.79	0.35	3.99	0.022
Lower lip to E-plane	5.26	2.89	1.13	2.18	-4.13	2.72	1.96	6.30	0.001
Nasolabial angle	94.22	10.19	105.39	12.16	11.17	10.60	-20.67	-1.68	0.023
Labiomental angle	138.17	16.92	140.08	12.97	1.91	13.26	-14.67	10.85	0.759
Interlabial gap	3.24	1.92	1.28	0.82	-1.96	1.78	0.71	3.21	0.004

: Significant at P ≤ 0.05

TABLE (4) Mean, standard deviation (SD) values and results of One Way ANOVA test for the comparison between changes in the three groups.

Variable	Group 1		Group 2		Group 3		P value
	MD	SD	MD	SD	MD	SD	
SNA	-1.12	2.52	-.02	2.11	0.25	2.12	0.270
SNB	-0.92	2.60	-.31	2.12	-0.28	1.76	0.702
ANB	-0.20	1.98	.29	1.32	0.53	1.33	0.490
FMA	0.00	2.73	-.62	2.02	0.22	2.47	0.680
Wits appraisal	0.34	2.75	-.20	1.91	-0.28	1.97	0.750
Overjet	-0.31	1.17	-2.03	2.27	-0.99	2.32	0.090
Overbite	0.53	0.94	-.20	1.74	0.70	1.02	0.190
U1 to FH	-8.19	5.56	-15.96	7.87	-15.97	9.08	0.016
U1 to SN	-7.88	4.09	-15.47	7.99	-15.53	8.89	0.012
IMPA	-4.09	6.46	-12.22	8.72	-12.65	5.08	0.004
Interincisal angle	12.28	7.96	28.79	10.29	28.40	11.05	0.001
U1 to NA(mm)	-1.51	2.58	-5.45	2.77	-5.34	2.21	0.001
L1 to NB(mm)	-1.95	2.51	-5.68	2.80	-5.05	3.27	0.004
Upper incisal display	0.06	0.87	-1.38	1.99	-1.42	1.39	0.020
Upper lip to E-plane	-1.21	2.65	-3.30	2.03	-2.17	1.79	0.070
Lower lip to E-plane	-1.72	3.30	-4.82	1.90	-4.13	2.72	0.010
Nasolabial angle	7.11	17.00	16.83	9.19	11.17	10.60	0.170
Labiomental angle	-3.53	16.44	-8.25	14.56	1.91	13.26	0.260
Interlabial gap	-0.94	0.68	-.98	1.07	-1.96	1.78	0.080

: Significant at P ≤ 0.05

DISCUSSION

The aim of this study was to evaluate the soft tissue changes resulting from different retraction techniques following upper first premolar extraction and anterior segment retraction. In this study, three groups of patients were treated with different retraction techniques: en-masse retraction with a 0.019” × 0.025” stainless steel archwire (Group 1), en-masse retraction with a thinner 0.017” × 0.025” stainless steel archwire (Group 2), and two-step retraction with a 0.017” × 0.025” stainless steel archwire (Group 3).

The results demonstrated statistically significant differences in the retroclination of both the upper and lower incisors among the three groups. Groups 2 and 3, which underwent en-masse retraction with a thinner archwire and two-step retraction, respectively, exhibited greater retroclination of the upper and lower incisors compared to Group 1. This finding suggests that the choice of retraction technique can influence the positioning of the front teeth. One possible explanation for these differences lies in the amount of play or clearance between the archwire and the bracket slot. The thinner archwires used in Groups 2 and 3 may have allowed for more

freedom of movement within the bracket slot, facilitating greater tipping of the incisors during retraction. In contrast, the larger-diameter archwire in Group 1 might have offered greater resistance to tipping, resulting in less retroclination of the incisors.[12,13]

Furthermore, this study revealed a significant decrease in the amount of upper incisor display in Groups 2 and 3 compared to Group 1. This reduction in upper incisor display can have esthetic implications, as it may affect the smile line and overall attractiveness of the patient's smile.[4,14] It is worth noting that the en-masse retraction technique with the thinner archwire (Group 2) resulted in similar outcomes to the two-step retraction technique (Group 3) in terms of upper incisor display. This finding suggests that the choice of retraction technique, in combination with archwire dimensions, can influence not only the position of the incisors but also their esthetic visibility during smiling.

In terms of lower lip retraction, Groups 2 and 3 displayed a statistically significant increase compared to Group 1. This result suggests that the retraction techniques utilized in Groups 2 and 3 exerted a greater influence on the position of the lower lip. It is plausible that the increased retroclination of the upper and lower incisors in these groups contributed to the backward movement of the lower lip.[5,10,15] However, it is important to note that other factors, such as the thickness and tension of the lip musculature, may also have influenced the degree of lip retraction.[4]

The differences in soft tissue changes observed in this study may have additional explanations related to biomechanical factors. For instance, the use of a two-step retraction technique in Group 3 involves an initial phase of space closure followed by a subsequent phase of incisor retraction. This sequential approach allows for controlled and gradual movement of the incisors, potentially resulting in more favorable soft tissue changes.[1] In contrast, the en-masse retraction technique used in Groups 1 and 2 involves simultaneous movement of the entire anterior segment, which might lead to different force distributions and potentially less predictable soft tissue outcomes.[1]

Another aspect worth considering is the amount of play or clearance between the archwire and the bracket slot, which can influence the mechanics of tooth movement. The archwire-slot play affects the forces and moments transmitted to the teeth during retraction. Greater play can allow for more flexibility and tipping, while reduced play might promote bodily movement. Differences in the amount of play between the various archwire sizes used in this study could have contributed to the observed variations in incisor retroclination and subsequent soft tissue changes.[12]

The outcomes of this study highlight the importance of considering the soft tissue effects when selecting a retraction technique in orthodontic treatment. Orthodontists should carefully evaluate the specific needs and esthetic goals of each patient to determine the most suitable technique. The en-masse retraction technique with a thinner archwire (Group 2) and the two-step retraction technique (Group 3) both offer advantages in terms of retroclination of the front teeth and reduction in upper incisor display.

It is important to acknowledge the limitations of this study. The sample size was relatively small, and the study focused on a specific patient population. Future research with larger sample sizes and diverse patient groups would be beneficial to further validate these findings. Additionally, long-term follow-up studies are necessary to evaluate the stability of the observed soft tissue changes over time.

In conclusion, the present study demonstrated that the retraction technique used during orthodontic treatment can significantly impact soft tissue changes. The en-masse retraction technique with

a thinner archwire and the two-step retraction technique resulted in increased retroclination of the upper and lower incisors, reduced upper incisor display, and greater retraction of the lower lip. Orthodontists should carefully consider these findings when planning treatment and aim to achieve optimal esthetic outcomes based.

REFERENCES

1. Heo W, Nahm D-S, Baek S-HJTAO. En masse retraction and two-step retraction of maxillary anterior teeth in adult Class I women: a comparison of anchorage loss 2007;77:973-978.
2. Hoe TM, Ting J, Chui LS, Wen TM, Al-Juboori MJ. Variables and factors that may affect smile design: A mini 2015.
3. Almutairi TK, Albarakati SF, Aldrees AMJSMJ. Influence of bimaxillary protrusion on the perception of smile esthetics 2015;36:87.
4. Leonardi R, Annunziata A, Licciardello V, Barbato EJTAO. Soft tissue changes following the extraction of premolars in nongrowing patients with bimaxillary protrusion: a systematic review 2010;80:211-216.
5. Trisnawaty N, Ioi H, Kitahara T, Suzuki A, Takahashi IJTEJoO. Effects of extraction of four premolars on vermilion height and lip area in patients with bimaxillary protrusion 2013;35:521-528.
6. Almurtadha RH, Alhammadi MS, Fayed MM, Abou-El-Ezz A, Halboub EJJoEBDP. Changes in soft tissue profile after orthodontic treatment with and without extraction: A systematic review and meta-analysis 2018;18:193-202.
7. Kulshrestha RS, Tandon R, Chandra PJjoos. Canine retraction: A systematic review of different methods used 2015;4:1.
8. El-Marhoumy SM, El-Shenawy ME, El-Sakhawy M, El-Shorbagy EMJEDJ. Evaluation of mini-implant anchorage system for en-masse retraction of maxillary anterior teeth versus conventional method 2016;62:845-863.
9. Al-Sibaie S, Hajeer MYJEJoO. Assessment of changes following en-masse retraction with mini-implants anchorage compared to two-step retraction with conventional anchorage in patients with class II division 1 malocclusion: a randomized controlled trial 2014;36:275-283.
10. Upadhyay M, Yadav S, Nagaraj K, Patil SJAJoO, Orthopedics D. Treatment effects of mini-implants for en-masse retraction of anterior teeth in bialveolar dental protrusion patients: a randomized controlled trial 2008;134:18-29. e11.
11. Khlef HN, Hajeer MY, Ajaj MA, Heshmeh OJCcd. Evaluation of treatment outcomes of en masse retraction with temporary skeletal anchorage devices in comparison with two-step retraction with conventional anchorage in patients with dentoalveolar protrusion: a systematic review and meta-analysis 2018;9:513.
12. Wu J, Wang X, Jiang Y, Wu Z, Shen Q, Chen Y et al. Effect of archwire plane and archwire size on anterior teeth movement in sliding mechanics in customized labial orthodontics: a 3D finite element study 2022;22:1-10.
13. El-Bialy T, Alobeid A, Dirk C, Jäger A, Keilig L, Bourauel CJJoOOFdK. Comparison of force loss due to friction of different wire sizes and materials in conventional and new self-ligating orthodontic brackets during simulated canine retraction 2019;80.
14. ŽAGAR M, KNEZOVIĆ ZLATARIĆ DJJoE, Dentistry R. Influence of esthetic dental and facial measurements on the Caucasian patients' satisfaction 2011;23:12-20.
15. Papageorgiou SN, Cassina C, Vandevska-Radunovic V, Eliades TJJotWFoO. Incisor and profile alterations in extraction cases treated with standard Edgewise and pre-adjusted appliances: A controlled before-and-after study 2021;10:105-111.