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Efficacy Of Modified Bidimensional Bracket System in Orthodontic Management of Bimaxillary Protrusion: A Comparative Analysis

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ABSTRACT

Background: bimaxillary protrusion is a common orthodontic concern that often requires extraction-based treatment followed by space closure. Efficient retraction mechanics with minimal anchorage loss are crucial for achieving optimal treatment outcomes. While the conventional MBT bracket system is widely used, the modified bidimensional bracket system has been proposed as an alternative to enhance control over anchorage while enabling faster tooth movement.

Objective: This study aimed to compare the rate of retraction and anchorage loss in patients with skeletal or dentoalveolar bimaxillary protrusion treated with the conventional MBT bracket system and the modified bidimensional bracket system.

Methods: A total of 10 patients with bimaxillary protrusion were selected and divided into two groups (n=5 per group). Group A was treated with the conventional MBT bracket system, while Group B received treatment with the modified bidimensional bracket system. Lateral cephalograms were used to evaluate the rate of retraction and anchorage loss for each patient.

Result: The findings revealed significant differences between the two groups in terms of retraction efficiency and anchorage control. The modified bidimensional bracket system demonstrated significant control over anchorage while maintaining an effective rate of retraction compared to the conventional MBT bracket system.

Conclusion: The modified bidimensional bracket system may offer clinical advantages in cases requiring efficient space closure with minimal anchorage loss. Further studies with larger sample sizes are recommended to validate these findings.

Keywords: *Bidimensional system, Anchorage control, Orthodontic retraction*

1. INTRODUCTION

Orthodontists strive to resolve malocclusions efficiently. The orthodontic diagnosis and associated treatment plan often require retraction of anterior teeth, and in these cases, premolar extractions are normally performed. The tooth movement rate is important to enable the orthodontist to anticipate treatment duration, and a good understanding of the rates of maxillary and mandibular tooth movement as well as the amount of anchorage loss is the basis for making treatment more efficient.1

Retraction of anterior teeth is a common treatment procedure in orthodontics and can be performed by mainly enmasse or two stage retraction (separate canine retraction). However; closing spaces in two steps might take a longer treatment time. In addition, when canines are retracted individually, they tend to rotate and tip more than when six anterior teeth are retracted as a single unit thus making en-masse retraction more desirable.2

Anchorage is the resistance to unwanted tooth movement and is commonly described as the desired reaction of posterior teeth to space closure mechanotherapy to achieve treatment goals, ie, minimum, medium, maximum anchorage.3 Anchorage loss is a reciprocal reaction that could obstruct the success of orthodontic treatment by complicating the anteroposterior correction of malocclusion and possibly detracting from facial esthetics. A major concern when correcting severe crowding, excessive overjet, and bimaxillary protrusion is control of anchorage loss.

Introduction of bidimensional technique,4 in orthodontics by Gianelly, provided the foundation and framework for the modification and development of conceptual and mechanical alterations in bidimensional system by Rinchuse and Rinchuse, who proposed modified bidimensional system.5

Modified bidimensional system mainly constitutes of 18 mil bracket slot for anterior teeth while much larger brackets with slot size 22 mil were used in the posterior teeth and a single archwire of dimension 0.018”x0.025” was used for retraction, thus there would be no to very minimal play between archwire and bracket slot which mainly provides tight fit for better torque and three-dimensional control of anterior teeth. Proffit et al stated that that a minimum clearance of 0.002 inch to 0.004 inch between a bracket slot and an archwire is necessary to facilitate sliding mechanics. Thus, using a 0.018”x0.025” stainless steel wire with much larger 22 mil slot brackets in the posterior segment provides a clearance of 0.004 inch and a loose fit which will reduce the resistance for space closure by sliding and will aid in retraction.

Most of orthodontist working with a 22-mil bracket slot system ultimately finish their cases with a 0.019”x0.025” inch stainless steel archwire thus a play between an archwire and bracket slot could be observed throughout the system, whereas the modified bidimensional system has play only in posterior and complete control of anterior teeth with full sized 0.018”x0.025” inch finishing wires. With play in posterior and complete control in anterior, teeth may level and align faster and space closer maybe enhanced because of reduced resistance to sliding in posterior segments.6

Modified bidimensional system employs en masse retraction for the six anterior teeth for space closure rather than two step retraction. Two step retraction lengthens time duration of an orthodontic treatment also it’s not more efficacious in avoiding clinically meaningful anchorage loss.

Several studies have evaluated the rate of retraction of anterior teeth by en masse retraction7 and only a few have evaluated the torque control with bidimensional approach8, but no studies have been done to analyze and compare the loss of anchorage and rate of retraction by modified bidimensional approach with the conventional MBT system. To reconcile existing inconsistencies and lack of information a sample size compared with previous conventional studies is necessary.

2. MATERIAL AND METHODOLOGY

This study was conducted at the Department of Orthodontics and Dentofacial Orthopaedics, Bhabha College of Dental Sciences, Bhopal. Ethical clearance was obtained from the Institutional Ethical Committee. Ten patients meeting the inclusion and exclusion criteria were randomly divided into two groups: Group A, consisting of five patients treated with a modified bidimensional bracket system, and Group B, consisting of five patients treated with a conventional MBT bracket system.

The inclusion criteria for the study were patients aged 18–25 years undergoing orthodontic treatment with all four first premolars extracted and planned for en-masse retraction using the MBT prescription. Patients with mild to moderate bimaxillary protrusion, convex facial profiles, similar space discrepancies, and Angle’s Class I Type 1 malocclusion were included. Additionally, only patients willing to participate were considered. Exclusion criteria included severe skeletal discrepancies requiring orthognathic surgery, medically compromised patients, those under prolonged medication, individuals with cleft lip/palate, major facial trauma, craniofacial syndromes, neurological or psychiatric disorders, and those with periodontal disease.

The clinical procedure involved pretreatment record collection, including intraoral and extraoral examinations, lateral cephalograms, study models, and photographs. In Group A, modified bidimensional MBT brackets were bonded, while Group B received conventional MBT brackets. Levelling and alignment were achieved using NiTi archwires. The retraction phase involved en-masse retraction using crimpable hooks and e-chains, with Group A utilizing 0.019 × 0.025-inch SS wire

and Group B using 0.018 × 0.025-inch SS wire. Anchorage control in Group A relied on posterior anchorage without additional devices, whereas Group B utilized bidimensional brackets for enhanced control. No transpalatal arches (TPA) or temporary anchorage devices (TADs) were used to allow for natural anchorage comparison.

The study timeline included a levelling and alignment phase lasting 2–3 months, followed by a 10-week en-masse retraction and data collection phase. Regular follow-ups ensured consistency in force application. Data collection and analysis involved measuring the rate of retraction cephalometrically using DU3-MU5 and LAU3-LAU5 distances and anchorage control using Ptv-U6 and SN-U6 measurements. Statistical analysis was conducted to compare retraction rates and anchorage loss between the two groups.

3. RESULTS

Statistical analysis:

The statistical analysis was done using statistical package of social sciences (SPSS) software, v.22, the mean comparison of pre and post treatment values between groups was calculated by using independent student T test. The difference will be considered as significant, when the P value is below 0.05. All the qualitative data will be compared using the independent student T test.

FORMULAE:

Student 't' test

The comparison of the filling material left over using two groups at different regions of the root, is done by using the independent student 't' test.

$$t = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{S^2\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}}$$

S= Standard deviation

n_1= Number of samples in group 1

n_2= Number of samples in group 2

$\bar{x}_1$ = mean of group 1

$\bar{x}_2$ = mean of group 2

The significance of difference between the groups is stated by the obtained p value.

P<0.001 [Highly significant]

P< 0.05 [Significant]

P> 0.05 [Not Significant]

The descriptive data of the cephalometric analysis was tabulated. Rate of retraction is calculated by DU3-MU5 and LAU3-LAU5, the mean and standard deviation is calculated, the pre-treatment values and post treatment values of the control group and experimental group are separately calculated. Anchorage control is calculated by, Ptv-U6 and SN-U6, the mean and standard deviation is calculated, the pre treatment values and post treatment values of the control group and experimental group are separately calculated. The descriptive statistics of all the cephalometric analysis, minimum value, maximum value, mean and standard deviation of the control group and the experimental group were tabulated here. [Table 1-2]

The comparison was done between the obtained pre and post means of the cephalometric values of the rate of retraction, anchorage control, and anterior torque control using independent student t test, in both the control group and the experimental group. It was observed that the rate of retraction varied significantly in both the control and experimental groups, with a

highly significant P values (<0.001). When the anchorage control was analysed it was found that the anchorage varied significantly in the control group between pre and post treatment. On the other hand it was found that there was no significant difference found between the pre and post treatment values of the experimental group. Similarly, the comparison was done to test the variance between the values in control and experimental groups, among the rate of retraction, anchorage control, and anterior torque control using independent student t test. It was found that the difference was highly significant for rate of retraction and anchorage control, with P value <0.001[Table 3-4] [Graphs 1-2]

Table 1: Descriptive data of all the cephalometric data of the control group

Descriptive Statistics[a]					
	N	Minimum	Maximum	Mean	Std. Deviation
DU3-MU5	10	5.00	8.00	6.5000	1.31233
LAU3-LAU5	10	11.00	16.00	13.2000	2.08433
Ptv-U6	10	18.50	22.00	20.3000	1.27366
SN-U6	10	74.00	87.00	80.0000	4.08248
Valid N (listwise)	10				
a. GROUP = Control Group					

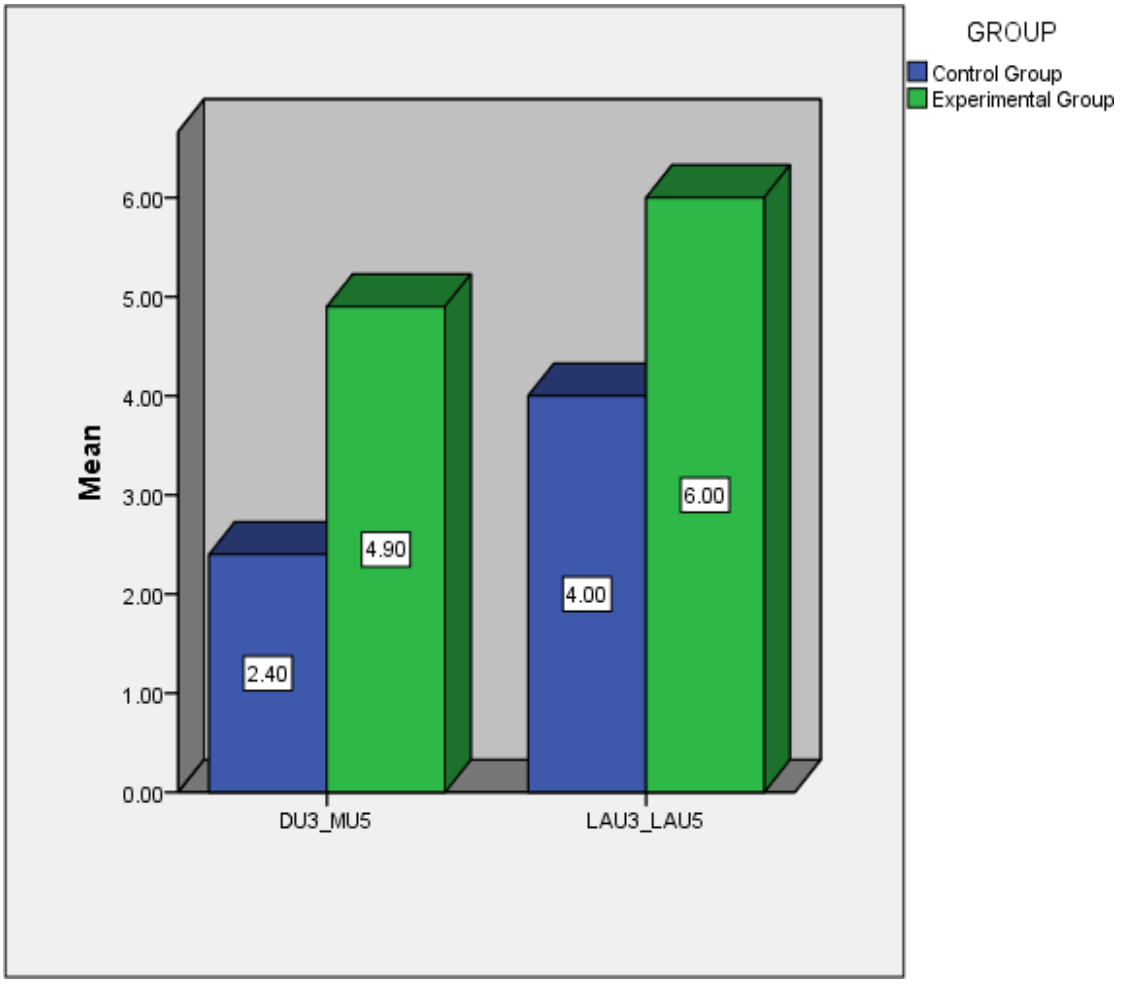
Table 2: Descriptive data of all the cephalometric data of the experimental group

Descriptive Statistics[a]					
	N	Minimum	Maximum	Mean	Std. Deviation
DU3-MU5	10	2.00	8.00	5.1500	2.60395
LAU3-LAU5	10	8.00	15.00	11.3000	3.11983
Ptv-U6	10	19.00	22.00	20.1500	1.00139
SN-U6	10	70.00	87.00	81.1500	4.90493
Valid N (listwise)	10				

a. GROUP = Experimental Group

Table 3: Comparison of the amount of space closure values by rate of retraction

	GROUP				P value
	Control Group		Experimental Group		
	Mean	SD	Mean	SD	
DU3_MU5	2.40	.42	4.90	.42	<0.001**
LAU3_LAU5	4.00	.35	6.00	.61	

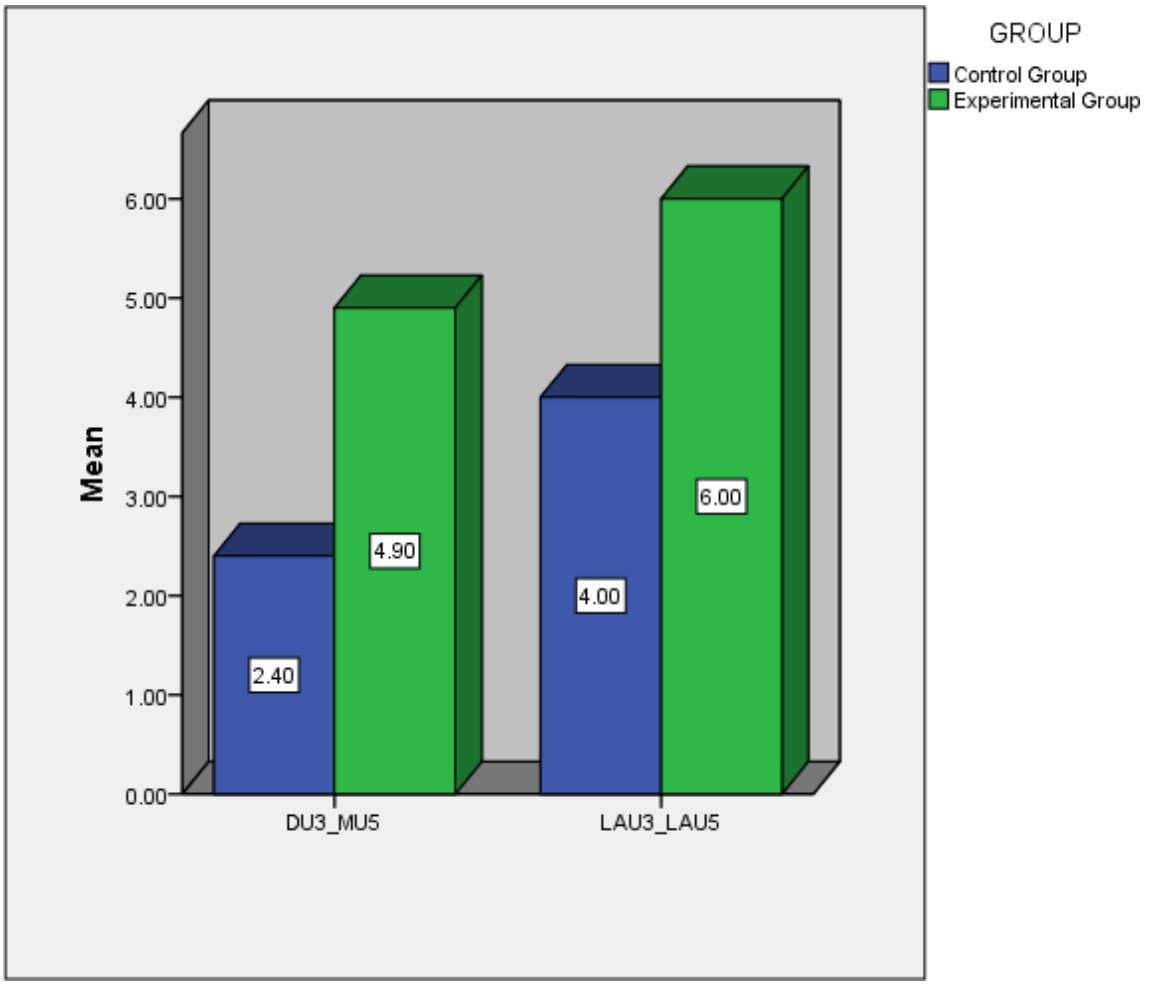


Graph 1: Comparison of the amount of space closure values by rate of retraction

Table 4: Comparison of the amount of anchorage loss

	GROUP		P value
	Control Group	Experimental Group	

	Mean	SD	Mean	SD	
Ptv_U6	2.20	.27	.70	.45	<0.001**
SN_U6	5.80	.84	1.90	.65	



Graph 2: Comparison of the amount of anchorage loss.

4. DISCUSSION

One of the major challenges in orthodontics is developing techniques that effectively control anchorage units while enabling faster tooth movement. Sliding mechanics for en-masse retraction of anterior teeth, as used in the MBT bracket system, are preferred over two-step retraction when anchorage is well maintained. However, the efficiency of space closure depends on the balance between minimizing anchorage loss and maintaining proper torque control of anterior teeth.

Anchorage loss is a critical concern in orthodontic treatment, particularly during space closure. To minimize posterior movement during retraction, the ideal wire or bracket slot should allow smooth sliding while maintaining torque control of the anterior teeth. Different types of archwires influence this process: rectangular wires provide excellent torque control but generate high friction, whereas round wires reduce friction but lack sufficient torque control. The ideal solution should combine both characteristics, allowing smooth sliding mechanics while preserving posterior anchorage.

To address these challenges, the bidimensional bracket system was introduced, incorporating different slot sizes for anterior and posterior teeth. This concept was first proposed by Schudy and Schudy2 in 1970 as the Bimetric System and was later modified by Gianelly3 into the Bidimensional Technique. This technique utilized 0.018-inch slots for incisors and 0.022-inch slots for canines, premolars, and molars, optimizing both torque control and sliding efficiency.

Further refinement of the bidimensional approach was achieved by Dr. Daniel J. Rinchuse and Dr. Donald J. Rinchuse6, who developed the Dual-Slot System. This system employs 0.018-inch bracket slots for anterior teeth and 0.022-inch bracket slots

for posterior teeth, combined with a 0.018”x0.025” stainless steel wire. The anterior segment, with smaller slots, ensures greater torque control, while the posterior segment, with larger slots, reduces friction, allowing for smoother space closure. This reduced resistance in the posterior region enhances treatment efficiency by promoting controlled anterior retraction while maintaining anchorage.

The present study evaluated the rate of retraction and anchorage control, in patients treated with the conventional MBT bracket system and the modified bidimensional bracket system. The findings demonstrated significant differences between the two groups, favoring the modified bidimensional system in terms of retraction efficiency and anchorage preservation.

The rate of retraction varied significantly between the control (MBT) and experimental (modified bidimensional) groups, with a highly significant P-value (<0.001). The modified bidimensional bracket system exhibited a significantly higher rate of retraction compared to the MBT system. This observation aligns with prior research suggesting that differential slot sizes in the bidimensional system enhance sliding mechanics, reducing friction and facilitating more efficient space closure. The reduced friction likely accelerates the retraction phase, making this system particularly beneficial in cases requiring substantial anterior retraction.

Anchorage analysis revealed significant differences between the two groups. In the control group (MBT), anchorage varied significantly between pre- and post-treatment values, whereas no significant difference was found in the experimental group (modified bidimensional). The post-treatment comparison between groups showed a highly significant difference in anchorage control.

Anchorage preservation is crucial in orthodontics, and the modified bidimensional system resulted in less anchorage loss compared to the MBT system. This finding corroborates existing literature, indicating that the larger anterior slot in bidimensional mechanics provides superior torque control, minimizing unwanted mesial movement of the posterior dentition. In contrast, the MBT system, which utilizes uniform slot dimensions, may lead to greater anchorage loss due to increased frictional resistance during space closure. The ability of the bidimensional system to mitigate anchorage loss highlights its clinical relevance, particularly in cases where absolute anchorage is a priority.

The findings of this study highlight the advantages of the modified bidimensional bracket system in orthodontic treatment. The system enhances retraction efficiency, reduces anchorage loss, and improves anterior torque control, making it a viable alternative to conventional MBT mechanics. Orthodontists may consider incorporating bidimensional mechanics in their treatment protocols, particularly in cases that demand maximum anchorage and controlled anterior retraction.

While this study provides valuable insights, the small sample size may limit the generalizability of the findings. Further research with larger sample sizes and long-term follow-up is recommended to validate these results. Additionally, incorporating three-dimensional imaging techniques in future studies could provide a more comprehensive assessment of torque control and anchorage loss. Continued research in this area will further refine orthodontic mechanics and contribute to improved treatment outcomes.

5. CONCLUSION

The modified bidimensional bracket system enhances orthodontic treatment by improving retraction efficiency and anchorage control. Its design balances torque control and reduced friction, leading to faster space closure with minimal anchorage loss compared to the MBT system. This approach offers a reliable alternative for cases requiring maximum anchorage preservation. Orthodontists may consider incorporating bidimensional mechanics for more predictable outcomes. Future research will further validate its long-term benefits.

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