Journal of Neonatal Surgery
ISSN(Online): 2226-0439
Vol. 14, Issue 32s (2025)
https://www.jneonatalsurg.com

OPEN ACCESS

Comparative Evaluation of Forsus Fatigue Resistant Device and Fixed Twin Block Appliance in the Treatment of Class II Division 1 Malocclusion

Rakesh Avadesh Singh[1], Pranita Jadhav[2], Vighanesh Kadam[3], Lirik Jongkey[4], Keval Shroff[5], Sameer Narkhede[6] , Dhaval Shah[7]

[1]Professor, Department of Orthodontics and Dentofacial Orthopaedics, D.Y. Patil University, School of Dentistry, Navi Mumbai

[2]Lecturer, Department of Orthodontics and Dentofacial Orthopaedics, D.Y. Patil University,School of Dentistry, Navi Mumbai

[3] Lecturer, Department of Orthodontics and Dentofacial Orthopaedics, D.Y. Patil University,School of Dentistry, Navi Mumbai

[4] Post graduate student, Department of Orthodontics and Dentofacial Orthopaedics, D.Y. Patil University, School of Dentistry, Navi Mumbai

[5] Lecturer, Department of Orthodontics and Dentofacial Orthopaedics, D.Y. Patil University,School of Dentistry, Navi Mumbai

[6] Professor, Department of Orthodontics and Dentofacial Orthopaedics, D.Y. Patil University, School of Dentistry, Navi Mumbai

[7] Post graduate student, Department of Orthodontics and Dentofacial Orthopaedics, D.Y. Patil University, School of Dentistry, Navi Mumbai

Corresponding Author:

Lirik Jongkey Email ID : jongkeylirik@gmail.com

Cite this paper as: Rakesh Avadesh Singh, Pranita Jadhav, Vighanesh Kadam, Lirik Jongkey, Keval Shroff, Sameer Narkhede , Dhaval Shah, (2025) Comparative Evaluation of Forsus Fatigue Resistant Device and Fixed Twin Block Appliance in the Treatment of Class II Division 1 Malocclusion. *Journal of Neonatal Surgery*, 14 (32s), 8279-8291.

ABSTRACT

Introduction: Class II Division 1 malocclusion, commonly caused by a retrognathic mandible, is one of the most frequently encountered orthodontic problems. While traditional removable functional appliances like the Twin Block have shown success in modifying growth, they require high patient compliance. Fixed functional appliances such as the Forsus Fatigue Resistant Device (FRD) offer a solution by providing continuous, compliance-free force. This study compares the clinical efficacy of these two appliances in growing patients.

Aim: To evaluate and compare the skeletal, dental, and soft tissue changes induced by Forsus FRD and Fixed Twin Block appliances in the treatment of Class II Division 1 malocclusion in growing individuals.

Materials and Methods:A prospective comparative study was conducted on 30 growing patients aged 12–14 years with skeletal Class II Division 1 malocclusion. The patients were divided into two groups: one treated with Forsus FRD and the other with Fixed Twin Block. Pre- and post-treatment lateral cephalograms were analyzed using composite cephalometric analysis, and skeletal, dental, and soft tissue changes were compared. The Pancherz method was used for superimposition. Statistical analyses were performed using paired and unpaired t-tests.

Results: Both appliances were effective in correcting Class II malocclusion. The Twin Block group showed greater skeletal changes, including a more significant increase in mandibular length and vertical control. Forsus FRD produced faster results and more pronounced dentoalveolar changes, including upper molar distalization and lower incisor proclination. Both groups exhibited soft tissue improvements, with slightly more favorable outcomes in the Twin Block group.

Conclusion: Both the Forsus FRD and Fixed Twin Block appliances are clinically effective for treating Class II Division 1 malocclusion. The choice of appliance should be based on individual patient needs, including compliance and treatment duration. While Twin Block is better suited for skeletal correction, Forsus is advantageous in non-compliant cases due to its fixed nature and shorter treatment time.

Keywords: *Class II Division 1 malocclusion, Forsus FRD, Fixed Twin Block, functional appliance, cephalometric analysis , skeletal correction, orthodontics*

INTRODUCTION

Skeletal Class II malocclusion represents one of the most prevalent sagittal orthodontic problems[1]. Treatment of Class II malocclusions can vary depending on factors such as age, amount of antero-posterior discrepancy, patient compliance, psychological aspects, and stability[2,3]. Treatment approaches include functional appliances, extractions and surgical orthodontic procedures. Functional orthopaedics, rooted in Moss's Functional Matrix Theory, aims to modify skeletal structure through changes in muscular function—often by repositioning the mandible forward using appliances.

While removable functional appliances like the Twin Block have been effective, they rely heavily on patient cooperation. This can be a significant challenge, especially with unmotivated or special needs patients. Fixed functional appliances provide a solution by delivering continuous force without relying on patient compliance. The Herbst appliance, developed in 1909, was the first fixed functional appliance, followed by others like the Jasper Jumper and Forsus Fatigue Resistant Device (FRD).

The Twin Block, introduced by William Clark in 1982[4], utilizes bite blocks with occlusal inclined planes that displace the mandible downward and forward on closure. Although originally designed as a removable appliance, fixed versions have been developed to overcome compliance issues.

Forsus FRD, developed by William Vogt in 2006[5], is a semi-rigid, fixed appliance that combines elements of the Jasper Jumper and Herbst[6]. It is easy to insert, requires minimal chairside time, and is well tolerated by patients. It does not restrict mandibular movements like lateral excursion and mouth opening causing less muscle fatigue.

With increased usage of Forsus and fixed Twin Blocks in modern orthodontic practice, this study aims to compare their skeletal, dental, and soft tissue effects in treating Class II Division 1 malocclusions.

This study seeks to compare the clinical effects of these two appliances—Forsus FRD and Fixed Twin Block—on skeletal, dental, and soft tissue structures using cephalometric analysis in growing Class II Division 1 patients.

AIMS AND OBJECTIVES

Aim: To evaluate and compare the skeletal, dental, and soft tissue cephalometric changes in Class II Division 1 patients treated with Forsus FRD and Fixed Twin Block appliances.

Objectives: To assess the skeletal, dental and soft tissue changes brought about by the Forsus Fatigue Resistant Device.

To assess the skeletal, dental and soft tissue changes brought about by the Twin Block.

To compare the skeletal, dental and soft tissue changes brought about by the Forsus Fatigue Resistant Device and the Twin Block.

To compare the efficacy of these two appliances in terms of time required to complete the treatment.

MATERIALS AND METHODOLOGY

Study Design and Setting:

A prospective, comparative clinical study was conducted at the Department of Orthodontics and Dentofacial Orthopaedics, D.Y. Patil School of Dentistry, Navi Mumbai. The average treatment period was 9 months. Ethical clearance was obtained, and informed consent was collected from all participants.

Sample Selection:

Thirty growing patients aged 12–14 years, were selected based on the following criteria:

Inclusion Criteria:

Patients in active growth period.

Positive VTO (Visualized Treatment Objective) on clinical evaluation.

Skeletal and dental Angle's Class II Division 1 malocclusion malocclusion with normal maxilla and retrognathic mandible.

CVM stage II-IV.

Average growth pattern

Overjet > 4 mm.

ANB > 4°.

No extracted permanent teeth.

No significant medical history.

Both male and female patients.

Exclusion Criteria:

Class I or III malocclusions.

Patients with completed growth.

Medically compromised patients

Grouping:

Group A (n=24): Treated with Forsus FRD manufactured by 3M Unitek 4 Corp Orthodontic Products, Monorovia California.

Group B (n=24): Treated with Fixed Twin Block.

Methodology:
Pre (T1) and Post functional lateral cephalograms (T2) were taken before the start and at the

end of the functional appliance therapy respectively. Average treatment time from T1 to T2

was 6 months for Forsus whereas was 9 months for Twin block. The cervical vertebral stage was recorded at start using the cervical vertebral maturation (CVM) method. The CVM stage at T1 was in range of 2 to 4 i.e. after the onset of puberty. All pre functional, and post functional cephalograms were digital radiographs following standardization protocol. These were printed on photo quality paper (Kodak 8000 system) and hand traced by a single operator on acetate paper using a 0.5mm pencil. Angular and linear measurements were performed using a composite analysis used in the Department of Orthodontics and Dentofacial orthopaedics. Superimpositions were performed between pre functional (T1) and post functional (T2) cephalograms using Pancherz method.

Parameters Measured:

The following angular and linear cephalometric parameters were used for the study:

Cranial Base

Saddle Angle: N-S-Ba (Bell, Proffit and White)

Anterior Cranial Base Length: N-S (Bell, Proffit and White)

Posterior Cranial Base Length: S-Ba (Bell, Proffit and White)

Maxillary Skeletal

Angle SNA (Steiner)

Nasion Perpendicular to Point A: N perpendicular Pt.A (McNamara)

Effective Midfacial Length : Co-A (Mcnamara)

Mandibular Skeletal

Angle SNB (Steiner)

Nasion perpendicular to Pogonion :N Pog (McNamara)

Effective mandibular length : Co- Gn (McNamara)

Condyle to Gnathion : Co –Gn

Condyle to Gonion : Co –Go (Whylie's)

Gonion to Gnathion : Go –Gn (Burstone)

Gonial Angle : Ar. Go. Me (Bjork)

Maxilla to Mandible (Skeletal)

Angle ANB (Steiner)

Wits appraisal :AO-BO (Jacobson)

Difference between Co-Gn and Co-A : CoGn-CoA (McNamara)

Vertical Relationship

Frankfurt Mandibular Plane Angle : FMA (Tweed)

Facial Axis :N Ba- PtmGn (Ricketts)

Lower Anterior Facial Height : LAFH (McNamara)

Maxillary Dental

Upper Incisor to NA line : U1-NA (Steiner)

Upper Incisor to SN plane : U1-SN (Jarabak)

Upper Incisor to A-Pogonion line: U1-APog (Downs)

Upper Incisor to ANS-PNS : U1 – ANS.PNS (Burstone)

Upper Molar to ANS-PNS : U6 – ANS.PNS (Burstone)

Upper Molar to Pterygoid Vertical : U6-PtV (Ricketts)

Mandibular Dental

Lower Incisor to NB line: L1 –NB (Steiner)

Incisor Mandibular Plane Angle: IMPA (Tweed)

Lower Incisor to A-Pog Line : L1-A Pog (Ricketts)

Lower Incisor To Mandibular plane: L1-MP (Burstone)

Lower Molar to Mandibular Plane: L6- MP (Burstone)

Maxilla to Mandible (Dental)

Interincisal Angle : U1-L1 (Steiner)

Overjet (Pancherz)

Overbite

Soft Tissue:

Soft tissue facial convexity angle : G-Sn-Pog' (Legan & Burstone)

Lower Lip to Ricketts E line: Li –E Line (Ricketts)

Nasolabial Angle : Cm –Sn –Ls (Legan & Burstone)

Statistical Analysis:

The findings of the study were statistically analysed using paired t-test for intragroup and unpaired t-test for intergroup analysis. A p-value of < 0.05 was considered statistically significant.

RESULTS

Table 1: Comparison of the skeletal, dental and soft tissue changes in terms of {Mean (SD)} among both the groups (forsus and twin block appliance) using unpaired t test.

Variables	*Group*	*N*	*Mean*	*Std. Deviation*	*t value*	*P value*
N-S-Ba pre	Forsus	15	130.08	3.6	0.702	0.490
	Twin Block	15	131.00	2.7		
N-S-Ba post	Forsus	15	130.42	3.5	0.505	0.618
	Twin Block	15	131.08	2.8		

N-S pre	Forsus	15	71.17	2.8	**2.251**	**0.035***
	Twin Block	15	67.83	4.2		
N-S post	Forsus	15	71.58	2.8	**2.457**	**0.022***
	Twin Block	15	68.08	4.0		
S-Ba pre	Forsus	15	48.83	2.4	**2.873**	**0.009***
	Twin Block	15	45.67	2.9		
S-Ba post	Forsus	15	49.17	2.8	1.748	0.094
	Twin Block	15	46.92	3.4		
S-N-A pre	Forsus	15	80.08	2.5	0	1
	Twin Block	15	80.08	2.5		
S-N-A post	Forsus	15	78.83	2.4	0.655	0.519
	Twin Block	15	79.42	1.8		
N-PtA pre	Forsus	15	-2.46	3.5	1.423	0.169
	Twin Block	15	-0.25	4.0		
N-PtA post	Forsus	15	-2.54	1.7	**2.240**	**0.036***
	Twin Block	15	-0.17	3.2		
Co-A pre	Forsus	15	88.67	4.0	**2.906**	**0.008***
	Twin Block	15	82.17	6.6		
Co-A post	Forsus	15	88.08	5.9	1.358	0.188
	Twin Block	15	85.50	2.7		
S-N-B pre	Forsus	15	74.33	2.5	0.334	0.741
	Twin Block	15	74.67	2.3		
S-N-B post	Forsus	15	76.92	2.2	1.003	0.327
	Twin Block	15	77.75	1.8		
N-Pog pre	Forsus	15	-5.92	7.6	0.631	0.535
	Twin Block	15	-7.58	4.9		
N-Pog post	Forsus	15	-3.08	4.9	0.270	0.789
	Twin Block	15	-2.58	4.0		
Co-Gn pre	Forsus	15	107.83	4.5	**3.745**	**<0.001****
	Twin Block	15	100.00	5.6		
Co-Gn post	Forsus	15	112.75	5.3	1.742	0.095
	Twin Block	15	109.42	3.8		
Co-Go pre	Forsus	15	53.25	3.5	**3.777**	**<0.001****
	Twin Block	15	47.92	3.3		

Co-Go post	Forsus	15	54.67	5.3	0.921	0.367
	Twin Block	15	53.00	3.3		
Go-Gn pre	Forsus	15	73.67	2.0	**2.539**	**0.019***
	Twin Block	15	68.83	6.2		
Go-Gn post	Forsus	15	77.25	2.9	**2.042**	**0.053***
	Twin Block	15	74.58	3.4		
Ar-Go-Me pre	Forsus	15	122.75	5.4	0.128	0.899
	Twin Block	15	122.50	3.9		
Ar-Go-Me post	Forsus	15	124.58	4.4	0.236	0.815
	Twin Block	15	125.00	4.2		
A-N-B pre	Forsus	15	5.33	1.0	0.197	0.846
	Twin Block	15	5.42	0.9		
A-N-B post	Forsus	15	1.92	0.6	0.294	0.771
	Twin Block	15	1.83	0.7		
AO-BO pre	Forsus	15	2.33	3.0	0.497	0.624
	Twin Block	15	2.92	2.6		
AO-BO post	Forsus	15	1.08	0.9	0.752	0.460
	Twin Block	15	0.83	0.7		
Diff Co-Gn & Co- PtA pre	Forsus	15	20.08	3.2	1.038	0.311
	Twin Block	15	18.58	3.7		
Diff Co-Gn & Co- PtA post	Forsus	15	24.33	2.9	0.069	0.946
	Twin Block	15	24.42	3.0		
FMA pre	Forsus	15	24.08	4.3	0.523	0.606
	Twin Block	15	25.25	6.3		
FMA post	Forsus	15	24.75	5.0	0.347	0.732
	Twin Block	15	25.50	5.5		
N Ba-ptm Gn pre	Forsus	15	87.50	4.3	0.370	0.715
	Twin Block	15	88.08	3.3		
N Ba-ptm Gn post	Forsus	15	89.00	3.6	0.963	0.346
	Twin Block	15	90.17	2.0		
LAFH pre	Forsus	15	60.83	6.0	**2.650**	**0.015***
	Twin Block	15	54.33	5.9		
LAFH post	Forsus	15	63.83	5.8	1.741	0.096
	Twin Block	15	60.17	4.4		

U1-NA pre	Forsus	15	29.17	4.8	**4.715**	**<0.001****
	Twin Block	15	36.92	2.9		
U1-NA post	Forsus	15	24.67	3.3	**2.465**	**0.022***
	Twin Block	15	28.25	3.7		
U1-NA Pre mm	Forsus	15	7.17	2.7	1.831	0.081
	Twin Block	15	8.83	1.4		
U1-NA Post mm	Forsus	15	5.17	1.8	1.818	0.083
	Twin Block	15	6.33	1.1		
U1-SN pre	Forsus	15	110.25	3.6	**4.207**	**<0.001****
	Twin Block	15	116.58	3.7		
U1-SN post	Forsus	15	104.75	3.3	**4.974**	**<0.001****
	Twin Block	15	111.42	3.2		
U1-Apog pre	Forsus	15	6.67	2.1	0.753	0.459
	Twin Block	15	7.33	2.2		
U1-Apog post	Forsus	15	5.17	2.0	0.449	0.658
	Twin Block	15	5.50	1.5		
U1-ANS PNS pre	Forsus	15	28.67	2.4	1.808	0.084
	Twin Block	15	25.83	4.8		
U1-ANS PNS post	Forsus	15	30.08	3.3	1.047	0.306
	Twin Block	15	28.92	1.8		
U6-ANS PNS pre	Forsus	15	20.42	2.4	0.061	0.952
	Twin Block	15	20.33	4.0		
U6-ANS PNS post	Forsus	15	19.33	3.3	0.405	0.689
	Twin Block	15	18.92	1.3		
U6-Ptv pre	Forsus	15	14.92	3.1	0.567	0.576
	Twin Block	15	14.33	1.7		
U6-Ptv post	Forsus	15	12.67	3.1	0.302	0.765
	Twin Block	15	13.00	2.1		
L1-NB pre	Forsus	15	24.58	5.4	0.410	0.686
	Twin Block	15	23.50	7.3		
L1-NB post	Forsus	15	30.58	5.1	0.263	0.795
	Twin Block	15	30.00	5.6		
L1-NB Pre mm	Forsus	15	4.92	1.7	1.308	0.204
	Twin Block	15	3.83	2.2		

L1-NBPost mm	Forsus	15	6.92	1.7	1.783	0.088
	Twin Block	15	5.58	1.8		
IMPA pre	Forsus	15	98.08	6.4	1.461	0.158
	Twin Block	15	94.17	6.7		
IMPA post	Forsus	15	102.42	6.7	1.045	0.307
	Twin Block	15	99.83	5.2		
L1-A Pog pre	Forsus	15	3.00	2.0	**2.253**	**0.035***
	Twin Block	15	0.92	2.5		
L1-A Pog post	Forsus	15	4.75	1.9	1.835	0.080
	Twin Block	15	3.50	1.3		
L1-MP pre	Forsus	15	37.42	7.0	0.576	0.570
	Twin Block	15	35.92	5.6		
L1-MP post	Forsus	15	38.67	6.3	0.037	0.971
	Twin Block	15	38.75	4.4		
L6-MP pre	Forsus	15	30.17	5.1	1.393	0.178
	Twin Block	15	27.42	4.4		
L6-MP post	Forsus	15	31.25	4.4	1.016	0.321
	Twin Block	15	29.58	3.5		
U1-L1 pre	Forsus	15	119.25	5.0	1.803	0.085
	Twin Block	15	115.33	5.6		
U1-L1 post	Forsus	15	121.25	5.7	0.729	0.474
	Twin Block	15	119.50	6.0		
G-Sn-Pog' pre	Forsus	15	18.83	3.0	**2.258**	**0.034***
	Twin Block	15	22.00	3.7		
G-Sn-Pog' post	Forsus	15	15.08	3.4	1.802	0.085
	Twin Block	15	17.75	3.7		
U lip-0E Line pre	Forsus	15	0.17	2.4	0.479	0.637
	Twin Block	15	-0.25	1.8		
U lip-E Line post	Forsus	15	-0.58	2.3	0.816	0.423
	Twin Block	15	-1.33	2.1		
L lip-0E Line pre	Forsus	15	1.08	1.9	**2.424**	**0.024***
	Twin Block	15	-1.50	3.1		
L lip-0E Line post	Forsus	15	2.08	1.7	1.162	0.258
	Twin Block	15	1.08	2.3		

Nasolabial Angle pre	Forsus	15	102.00	10.5	0.847	0.406
	Twin Block	15	98.25	11.1		
Nasolabial Angle post	Forsus	15	101.08	9.8	0.184	0.856
	Twin Block	15	100.33	10.1		

Table 2: Comparison of the mean difference (pre – post) of skeletal, dental and soft tissue changes in terms of {Mean (SD)} among both the groups (forsus and twin block appliance) using Mann Whitney U test.

Mean difference	Group	N	Mean	Std. Deviation	P value
N-S-Ba	Forsus	15	-0.33	0.9	0.568
	Twin Block	15	-0.08	1.0	
N-S	Forsus	15	-0.41	0.9	0.587
	Twin Block	15	-0.25	1.0	
S-Ba	Forsus	15	-0.33	0.8	0.137
	Twin Block	15	-1.25	1.8	
S-N-A	Forsus	15	1.25	0.6	**0.054***
	Twin Block	15	0.66	0.7	
N-PtA	Forsus	15	0.08	2.4	0.907
	Twin Block	15	-0.08	3.1	
Co-A	Forsus	15	0.58	3.0	0.097
	Twin Block	15	-3.33	5.9	
S-N-B	Forsus	15	-2.58	0.7	0.088
	Twin Block	15	-3.08	0.6	
N-Pog	Forsus	15	-2.83	3.6	0.096
	Twin Block	15	-5.00	2.9	
Co-Gn	Forsus	15	-4.91	3.1	**0.032***
	Twin Block	15	-9.41	5.8	
Co-Go	Forsus	15	-1.41	2.7	**0.006***
	Twin Block	15	-5.08	4.1	
Go-Gn	Forsus	15	-3.58	1.9	0.171
	Twin Block	15	-5.75	4.7	
Ar-Go-Me	Forsus	15	-1.83	2.9	0.363
	Twin Block	15	-2.50	2.1	
A-N-B	Forsus	15	3.41	1.0	0.758
	Twin Block	15	3.58	0.9	

AO-BO	Forsus	15	1.25	2.8	0.680
	Twin Block	15	2.08	2.4	
Diff Co-Gn & Co-PtA	Forsus	15	-4.25	1.4	0.069
	Twin Block	15	-5.83	2.1	
FMA	Forsus	15	-0.66	1.6	0.905
	Twin Block	15	-0.25	2.5	
N Ba-ptm Gn	Forsus	15	-1.50	2.2	0.836
	Twin Block	15	-2.08	2.3	
LAFH					**0.015***
	Forsus	15	-3.00	1.0	
	Twin Block	15	-5.83	3.1	
U1-NA	Forsus	15	4.50	3.2	**0.005***
	Twin Block	15	8.66	3.0	
U1-NA mm	Forsus	15	2.00	1.3	0.337
	Twin Block	15	2.50	1.2	
U1-SN	Forsus	15	5.50	2.6	0.930
	Twin Block	15	5.16	3.6	
U1-Apog	Forsus	15	1.50	1.3	0.497
	Twin Block	15	1.83	2.2	
U1-ANS PNS	Forsus	15	-1.41	1.5	0.278
	Twin Block	15	-3.08	3.8	
U6-ANS PNS	Forsus	15	1.08	1.3	0.616
	Twin Block	15	1.41	3.7	
U6-Ptv	Forsus	15	2.25	0.6	**0.008***
	Twin Block	15	1.33	0.8	
L1-NB	Forsus	15	-6.00	2.9	0.663
	Twin Block	15	-6.50	3.4	
L1-NB mm	Forsus	15	-2.00	1.0	0.470
	Twin Block	15	-1.75	1.1	
IMPA	Forsus	15	-4.33	3.4	0.281
	Twin Block	15	-5.66	2.8	
L1-A Pog	Forsus	15	-1.75	0.4	0.232
	Twin Block	15	-2.58	1.7	
L1-MP	Forsus	15	-1.25	2.2	**0.053***

	Twin Block	15	-2.83	1.5	
L6-MP	Forsus	15	-1.08	2.0	0.115
	Twin Block	15	-2.16	2.1	
U1-L1	Forsus	15	-2.00	6.7	0.524
	Twin Block	15	-4.16	4.8	
G-Sn-Pog'	Forsus	15	3.75	1.2	0.195
	Twin Block	15	4.25	1.0	
U lip-0E Line	Forsus	15	0.75	1.2	0.258
	Twin Block	15	1.08	1.7	
L lip-0E Line	Forsus	15	-1.00	1.2	**0.005***
	Twin Block	15	-2.58	1.0	
Nasolabial Angle	Forsus	15	0.91	3.2	0.059
	Twin Block	15	-2.08	3.7	

($p < 0.05$ - Significant*, $p < 0.001$ - Highly significant)**

DISCUSSION

Skeletal Changes:

The FRD group showed more of a "headgear effect" than TB group. This difference may result from force distribution across the entire maxillary dentition rather than just the upper molar. Headgear effect in the FRD group aligns with the studies conducted by Karacay[7], Darda[8] et al., but differs from the observations of Golz[9], and Jones[10] et al., who reported a 1.7 mm anterior movement of the maxilla.

The TB group showed a restraining effect on maxilla, consistent with findings by Clark[11], Toth[12], Mills and McCulloch[13,14], Bacetti[15], and Trenouth[16] et al., but contrary to Morris and Illing[17], who reported forward movement of the maxilla.

Increase in mandibular length was noted more in TB group. Increase in mandibular length is in accordance with studies by Jones[10], Darda[8], Karacay[7], Toth[12], Mills[13,14], Jena[18,19], Franchia[20] et al.

Increase in ramus height was more in TB group which is in accordance with study by Schafer[21] et al.

Mandibular body length and sagittal corrections were observed more in the TB group than the FRD group.

Additionally there was increased lower anterior facial height in both the groups , but more in TB group due to increase in ramus height along with trimming of appliance leading to eruption of lower molars.

Dental Changes:

Correction of overjet, overbite and molar relationship occurred more in the TB group than the FRD.

Retroclination of upper incisors was seen in both the groups but more in TB group which might be due to contact of lip musculature i.e. orbicularis oris, exerting pressure on the upper incisor. Retroclination of upper incisors in TB group was also observed in studies by Clark[11], Trenouth[16], Jena[18,19] et al.

Proclination of lower incisors was observed more in the TB group than FRD group after the functional treatment.

Distalization and intrusion of upper molar was observed more in the FRD group than the TB group due to vector of force being below and behind the center of resistance of the maxillary dentition. Intrusion and distalization of the maxillary molars in the FRD group is in accordance with studies by Vogt[22], Karacay[7] and Franchia[20] et al., but differs from Oztoprak[23] et al's findings.

Mesialization and extrusion of lower molar was observed more in the TB group than the FRD group due to downward and forward force to the mandibular dentition. This is consistent with studies of Clark[11], Lund and Sandler[24], O'Brien[25], Bacetti[15],

Mills[13,14], Toth[12], Schafer[21] and Jena[18,19] et al.

Soft Tissue Changes:

Both groups showed similar amount of soft tissue changes.

Decrease in facial convexity angle was more in TB group which may be attributed to more of skeletal improvements. Decrease in facial convexity angle in FRD group is consistent with previous studies of Karacay[7], Oztoprak[23] et al.

Decrease in upper lip to E line upper and increase in lower lip to E line was also seen more in the TB group which was achieved by jumping of the bite i.e. due to forward positioning of the mandibular component and due to upper incisor tipping.

Improvement in the E line measurements, facial convexity angle and pogonion noted in TB group are consisted with studies of Schafer[21] and Sharma[27] et al.

While Twin Block offers greater skeletal benefit, it demands high compliance. Forsus, although less effective skeletally, ensures continuous force application, which is ideal for patients with variable motivation or compliance issues. The findings support the utility of both appliances but reinforce the need for appliance selection based on patient-specific criteria.

CONCLUSION

Forsus FRD and Fixed Twin Block appliances effectively treat Class II Division 1 malocclusion. Skeletal effects were noted in the Twin Block group, which also provided better vertical control. Both methods showed no differences in soft tissue profiles. FRD had shorter treatment times than Twin Block. Clinical judgment is necessary to choose between TB, a cost-effective option, and FRD, which is more comfortable and convenient. Patient-centered treatment should be prioritized.

Conflict of Interest: The authors declare no conflict of interest.

Acknowledgments: We thank all participating orthodontists and the Department of Orthodontics, D.Y. Patil University, for their support.

Funding: No external funding was received for this study.

REFERENCES

1. Profit WR, Fields HW, Moray LJ. Prevalence of malocclusion and orthodontic treatment need in the United States: estimates from NHANES-III survey. Int J Adult Orthod Orthognath Surg. 1998; 13:97-106.
2. Tung AW, Kiyak HA. Psychological influences on the timing of orthodontic treatment. Am J Orthod Dentofacial Orthop. 1998;113:29-39.
3. Linklater RA, Fox N A. The long-term benefits of orthodontic treatment. British Dental Journal. 2002; 192:583-597.
4. William Clark .Twin Block Functional Therapy ,Applications in Dentofacial Orthopedics, IInd edition, 2002.
5. Vogt W .The Forsus Fatigue Resistant Device .J Clin Orthod. 2006;40 : 368-377.
6. Heinig N , Goz G .Clinical Applications and effect of the Forsus spring.A study of a new Herbst Hybrid. J Orofac Orthop. 2001;62:436-450.
7. Seniz Karacay, Erol Akin, Huseyin Olmez, Umit Gurtonb, Deniz Sagdic. Forsus Nitinol Flat Spring and Jasper Jumper. Corrections of Class II division 1 Malocclusions. Angle Orthod.2006;76:666- 672.
8. Milind Darda, Sumant Goel, Ravi Gupta. A cephalometric comparision of the dentoskeletal changes in Class II malocclusion by using Jasper Jumper and Forsus- A clinical study. Int J Contemporary Dentistry 2010; 79-86.
9. Heinig N , Goz G .Clinical Applications and effect of the Forsus spring.A study of new Herbst Hybrid. J Orofac Orthop. 2001; 62:436-450.
10. Graham Jones ,Peter H. Buschang, Ki Beom Kim, Donald R.Oliver Class II Non extraction patients treated with the Forsus Fatigue Resistant Device Versus Intermaxillary Elastics. Angle Orthod.2008;78:332-338.
11. William C.J. The Twin Block technique ; A functional orthopaedic appliance system. Am J Orthod Dentofac Orthop. 1900; 93: 1-18.
12. Ratner Toth and James A . Mcnamara , Jr . Treatment effects produced by the Twin Block appliance and the FR2 applaince of Frankel compared with an untreated Class II sample . Am J Orthod Dentofacial Orthop 1999; 116: 597-609.
13. Christine M Mills , Kara J McCulloch. Treatment effects of the Twin Block appliance : A cephalometric study. Am J Orthod Dentofacial Orthop. 1998; 114: 15-24.
14. Christine M Mills , Kara J McCulloch.Post treatment changes after successful correction of class II malocclusions with twin block appliance . Am J Orthod Dentofacial Orthop.2000 ; 118: 24- 33.
15. Tiziano Baccetti, Lorenzo Franchi, Linda Ratner Toth , James A Mcnamara. Treatment timing for Twin Block therapy. Am J Orthod Dentofacial Orthop 2000;118:159-170.

16. Trenouth MJ. A functional appliance system for correction of Class II relationships. Br J Orthod. 1989 ;16:169-176.
17. Illing, Morris, Lee. A prospective evaluation of bass, Bionator and Twin block appliances .Part I –the hard tissues. Eur J Orthod. 1998; 20(5): 501-516.
18. Jena ,Ritu Duggal, Hare Parkash, Ashok Kumar. Skeletal and dentoalveolar effects of Twin Block and bionator applainces in the treatment of Class II malocclusion: Am J Orthod Dentofacial Orthop A comparative study. 2006;130:594-602.
19. Ashok Kumar Jena, Ritu Duggal .Treatment effects of Twin Block and Mandibular Protraction Appliance-IV in the correction of Class II Malocclusion.Angle Orthod. 2010; 80:485-491.
20. Lorenzo Franchia , Lisa Alvetro , Veronica Giuntini , Caterina Masucci, Efisio Defraia, Tiziano Baccetti. Effectiveness of Comprehensive fixed appliance treatment used with the Forsus Fatigue Resistant Device in Class II patients. Angle Orthod 2011: 81:678-683.
21. Abbie T. Schaefer, James A. Mcnamara, Lorenzo Frnachi, Tiziano Baccetti. A cephalometric comparision of treatment with the Twin Block and stainless steel crown Herbst applainces followed by Fixed appliance therapy. Am J Orthod Dentofacial Orthop 2004;126:7-15.
22. Vogt W .The Forsus Fatigue Resistant Device .J Clin Orthod. 2006;40 : 368-377.
23. Oztoprak MO, Nalbantgil D, Uyanlar A, Arun T. A cephalometric comparative study of class II correction with Sabbagh Universal Spring (SUS(2)) and Forsus FRD appliances. Eur J Dent. 2012 Jul;6(3):302-10. PMID: 22904659; PMCID: PMC3420838.
24. David Ian Lund, Paul Jonathan Sandhler. The effects of Twin Blocks: A prospective controlled study. Am J Orthod Dentofacial Orthop. 1998; 113:104-110.
25. O'Brien K, Wright J, Conboy F, Sanjie Y, Mandall N, Chadwick S, Connolly I, Cook P, Birnie D, Hammond M, Harradine N, Lewis D, McDade C, Mitchell L, Murray A, O'Neill J, Read M, Robinson S, Roberts-Harry D, Sandler J, Shaw I. Effectiveness of treatment for Class II malocclusion with the Herbst or twin-block appliances: a randomized, controlled trial. Am J Orthod Dentofacial Orthop. 2003 Aug;124(2):128-37. doi: 10.1016/s0889-5406(03)00345-7. PMID: 12923506.
26. Ashvin A Sharma, Robert T.Lee. Prospective clinical trial comparing the effects of conventional Twin Block and mini Block appliances.Part -2.Soft tissue changes. Am J Orthod Dentofacial Orthop 2005;127:473-482.