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Original Research Article

Comparative evaluation of treatment outcome in skeletal class II malocclusion with Twin Block, Forsus and bilateral sagittal split osteotomy

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Abstract

Background: The evaluation of skeletal, dental & soft tissue is a prime importance in Class II malocclusion in orthodontics. Various treatment protocols used for correction of Class II malocclusion bring about changes in the skeletal, dental &soft tissue. Therefore, a need was felt for comparing the changes in skeletal, dental and soft tissue parameters in Class II subjects treated with Twin block, Forsus fixed functional appliance and BSSO mandibular advancement surgery.
Materials and Methods: Standardized lateral cephalograms of patients were screened according to treatment methodology-Twin Block, Forsus fixed functional appliance and BSSO mandibular advancement surgery. 45 patients thus selected were divided into Twin Block, Forsus fixed appliance group and BSSO mandibular advancement group (15 each). Pre and post treatment cephalograms of each patient were analysed for linear and angular measurements.
Results: On comparing Twin block pre and post treatment values in relation to skeletal, dental and soft tissue parameters. There was highly significant change in the SNB, ANB, ANS-Me and U1-to NA-Angle, U1-to NA-Linear. S line to U-LIP values were also clinically significant.
On comparing Forsus pre and post treatment values in relation to skeletal, dental and soft tissue parameters, there was highly significant change in the Go-Gn -SN, S line to L-LIP and SNB, ANB, ANS-Me, Maxillary length and U1-to NB-Angle, U1-to NA-Linear, S line to U-LIP values were clinically significant.
On comparing BSSO pre and post treatment values in relation to skeletal, dental and soft tissue, there was highly significant change in the SNB, ANB, ANS-Me, Go-Gn-SN, Mandibular length. SNB values were also clinically significant. There was highly significant change in the U1-to NA-Linear, S line to U-LIP values were also clinically significant.
Conclusion: It can be concluded from the present study that skeletal parameters improve more with BSSO advancement followed by Twin block as compared to Forsus fixed functional appliance. There is more improvement in ANB, lower anterior facial height in all the three groups.

Keywords: Forsus fixed functional appliance, BSSO mandibular advancement surgery, Twin block.

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1. Introduction

Class II malocclusion is reported to be one of the most common orthodontic problems contributing approximately one third of the population. The most common clinical finding of Class II malocclusion is mandibular skeletal retrusion, which can be eliminated by increasing the mandibular growth and preventing the disharmony of the skeletal jaw base and the unesthetic facial appearance. Different types of functional appliances, both removable and fixed types, have been used to stimulate mandibular growth to correct skeletal and occlusal discrepancies.[1]

Straight profiles have been considered to be more aesthetic and thus functional appliance treatment revolves around the objective of attaining straighter profile with balanced facial proportions. The improvement in facial aesthetics occurs by a combination of skeletal and dental changes to varying degrees depending on the type of appliance. Different removable and fixed functional appliances are being used for the treatment of skeletal class II malocclusion in growing patients. The advantage of fixed functional appliances lay in circumventing the patient compliance problem, usually associated with routinely used removable functional appliances. As the mandible is more

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retrognathic in relation to the anterior cranial base, it decreases the space between cervical column and mandibular corpus and leading to posteriorly positioned tongue and soft palate.[1]

There is a variety of Class II treatment modalities, such as extraoral appliances, functional appliances, fixed appliances, or orthognathic surgical procedures depending on the underlying etiology and age of the subject at the beginning of treatment.[2]

Functional appliances form the optimum treatment option for mandibular retrognathism in growing children. Forsus is the fixed functional appliance used to treat moderate Class II patients and requires minimum patient compliance.[3] BSSO (bilateral sagittal split osteotomy) is the most commonly performed orthognathic surgery for mandibular advancement. It was first described by Trauner and Obwegesor in 1957. Severe Class II cases are treated by this technique.[4]

BSSO is most commonly performed jaw surgery, either with or without upper jaw surgery in horizontal mandibular deficiency cases. But limited studies have been done to compare skeletal, dental and soft tissue changes by using Twin block, Forsus and BSSO.

The present study is carried out to evaluate and compare the treatment outcome by using Twin block, Forsus fixed functional appliance treatment and BSSO mandibular advancement surgery during treatment of a skeletal Class II malocclusion due to retrognathic mandible. The study is to evaluate and compare the treatment outcome in to relation to skeletal, dental and soft tissue parameters in skeletal class II cases with retrognathic mandible by using Twin block, Forsus and BSSO.

2. Aims and Objectives of the Study

2.1. Aims

To evaluate and compare the treatment outcome in management of skeletal class II cases treated with Twin Block, Forsus fixed functional appliance and BSSO mandibular advancement surgery

3. Objectives

1. To assess the skeletal, dental and profile changes after use of
    a. Twin block functional appliance.
    b. Fixed functional appliance (Forsus).
    c. BSSO, in the management of class II skeletal malocclusion with retrognathic mandible.
2. To evaluate and compare the best outcome of the above three modalities.

4. Materials and Methods

4.1. Materials

1. 8″x10″Lateral cephalogram film.
2. 8″x10″ acetate matte tracing paper, 0.003″ in thickness.
3. X-ray view-box.
4. 0.35 mm tracing pencil.
5. Protractor and ruler.

4.2. Source of the data

Treatment records of Department of Orthodontics and Dentofacial Orthopaedics, CODS, Davangere were screened for Digital Lateral Cephalograms taken with Romexis Planmeca 2.3.1 version cephalostat.

The lateral cephalometric radiographs were taken using the same digital cephalostat in a standardized method and in a natural head position were screened to be a part of the study. (**Figure 1**)

4.3. Method of collection of data

45 patients were selected and divided into Twin Block, Forsus fixed appliance group and BSSO mandibular advancement group (15 each). Pre and post treatment cephalograms of each patient were analysed for linear and angular measurements. The lateral cephalograms were initially screened according to the following criteria (Figure 2).

1. Age group: - Twin block appliance (11± 3) yrs.
1. Forsus appliance (14 ± 2) yrs.
2. BSSO (>16) yrs.
2. Standardized Digital Lateral Cephalograms taken in NHP and with optimum quality and visibility with magnification of 107%.
3. Group 1- patients with skeletal Class II malocclusion treated by Twin Block – pre and post - treatment lateral cephalograms.
4. Group 2- patients with skeletal Class II malocclusion treated using Forsus (3M Unitek, Monrovia, Calif) fixed functional appliance – pre and post -treatment lateral cephalograms.
5. Group 3- patients with skeletal Class II malocclusion treated by surgical BSSO advancement - pre and post - treatment lateral cephalograms.
6. Patients in both groups had Skeletal Class II malocclusion ANB ≥ 4°, SNB ≤78°, Overjet ≥ 5mm, Class II molar relationship.

The following patients were excluded from the study:

1. Previous history of orthodontic treatment.
2. Presence of any craniofacial anomaly / syndromic individual.
3. Medically compromised individuals.

5. Results

In the present study, skeletal, dental and soft tissue parameter were measured pre-treatment and post- treatment with the three treatment protocols for correction of class II malocclusion due to retrognathic mandible. Out of 45 patients 15 were divided into each group Twin block (Group 1), Forsus Fixed Functional Appliance (Group 2) and BSSO surgical advancement (Group 3). Further, the comparison was done between the three groups.

The data were entered into MS Excel 2016 and the statistical analysis was carried out by SPSS Software Version 23.

Table 1 shows the difference in skeletal, dental and soft tissue parameters in twin block pre-treatment and post treatment. There was highly significant increase in the SNB (1.7±0.4 º), ANS-Me (2.5±0.5mm), decrease in ANB (2±0.1 º), U1-to NA-angle (6±3 º), U1-to NA-linear (2.8±0.8mm). S line to U-LIP values were also clinically significant decreased by (0.9±0.4mm).

Table 2 shows the difference in skeletal, dental and soft tissue parameters in Forsus pre-treatment and post treatment. There was highly significant increase in the Go-Gn -SN (2.9± 0.5 º), ANS-Me (4.2±2.7mm) and decrease in S line to L-LIP (0.39± 2.7mm) and SNB (1.3± 0.8 º), ANB (0.66±0.1 º), Maxillary length (0.8±0.47mm), and L1-to NB-angle (7.6±2.2 º), U1-to NA-linear (2.2±0.1mm), S line to U-LIP values were clinically significant (0.7±0.1mm).

Table 3 shows the difference in skeletal parameters in BSSO pre-treatment and post treatment. There was highly significant decrease in the SNA (2.5± 1.2 °), ANB (2.9±0.7°) and increase in ANS-Me (3.4±2.5mm), Go-Gn-SN (1±3.1°), Mandibular length (6.6±2.46mm). Decrease in SNB values were also clinically significant (1.2±0.1 °). This significant difference is depicted in table 3.

Table 4 shows the difference in dental and soft tissue parameters in BSSO pre-treatment and post treatment. There was highly significant decrease in the U1-to NA-linear (2.5±0.3mm). Decrease in S line to U-LIP values were also clinically significant (1.9±2.2mm).

On overall comparison the pre-treatment skeletal, dental and soft tissue parameters between twin block, Forsus and BSSO groups all the values were clinically insignificant except decrease in ANB by 2.04±1.07 ° in BSSO is more than in Forsus and decrease in L1-to NB-angle by 8.3±4.8 ° in Twin block is more than in Forsus were clinically significant as shown in table 5 depicted in **Figure 1**, **2 and 3.**

On overall comparison the post-treatment skeletal, dental and soft tissue parameters between twin block, Forsus and BSSO groups all the values were clinically insignificant except increase in mandibular length by 8.1±4.3mm in BSSO is more than in Twin block which was clinically significant as shown in **Table 5** depicted in **Figure 1**, **2 and 3.**

Table 1: Comparison of pre and the post skeletal, dental & soft tissue parameters in Twin block group

		Mean	N	Std. Deviation	Mean diff	T	P value
Pair 1	SNA-pre	79.1333	15	4.12080	-0.13	-0.24	0.80
	SNA-post	79.2667	15	3.39046			
Pair 2	SNB-pre	74.4000	15	2.72029	-1.73	-3.59	0.003 HS
	SNB-post	76.1333	15	2.32584			
Pair 3	ANB-pre	5.2667	15	1.27988	1.8	5.28	0.000 HS
	ANB-post	3.4667	15	1.35576			
Pair 4	GOGN-TO-SN-pre	28.7333	15	6.04113	-0.63	-0.51	0.61
	GOGN-TO-SN-post	29.3667	15	3.60786			
Pair 5	ANS-ME-pre	60.5333	15	4.77892	-2.46	-3.51	0.003 HS
	ANS-ME-post	63.0000	15	4.22577			
Pair 6	MAX-LENGTH-pre	86.5000	15	5.94919	0.56	0.16	0.87
	MAX-LENGTH-post	85.9333	15	12.38932			
Pair 7	MAND-LENGTH-pre	105.4333	15	6.39438	-2.1	-1.45	0.16
	MAND-LENGTH-post	107.5333	15	6.86468			
Pair 8	Y-ANGLE-pre	68.2000	15	8.17837	0.53	0.27	0.78
	Y-ANGLE-post	67.6667	15	2.58199			
Pair 9	FAA-pre	.5333	15	6.17445	1.4	1.06	0.30
	FAA-post	-.8667	15	2.64215			
Pair 10	U1-TO-NA-ANGLE-Pre	32.9333	15	7.62952	6.0	3.43	0.004 HS
	U1-TO-NA-ANGLE-Post	26.9333	15	4.66701			
Pair 11	U1-TO-NA-LINEAR-Pre	9.6333	15	2.83767	2.7	4.79	0.000 HS
	U1-TO-NA-LINEAR-Post	6.8667	15	2.00416			
Pair 12	L1-TO-NB-ANGLE-Pre	30.7333	15	6.04113	-2.53	-1.24	0.23
	L1-TO-NB-ANGLE-Post	33.2667	15	4.75795			
Pair 13	L1-TO-NB-LINEAR-Pre	6.7667	15	2.12860	-0.6	-1.02	0.32
	L1-TO-NB-LNEAR-Post	7.3667	15	2.10837			

Pair 14	IA-Pre	111.9333	15	11.05484	-5.53	-1.65	0.12
	IA-Post	117.4667	15	7.65195			
Pair 15	S-LINE-TO-U-LIP-Pre	3.4667	15	1.64172	0.9	2.30	0.03 S
	S-LINE-TO-U-LIP-Post	2.5667	15	1.23732			
Pair 16	S-LINE-TO-L-LIP-Pre	3.2333	15	3.25613	-0.1	-0.24	0.81
	S-LINE-TO-L-LIP-Post	3.3333	15	2.50476			
Pair 17	NA Pre	94.4000	15	12.10549	0.2	0.08	0.93
	NA Post	94.2000	15	10.12917			

Statistical test applied: Paired samples t test; HS – Highly significant at p<0.01; S – Significant at p<0.05

Table 2: Comparison of pre and the post skeletal, dental & soft tissue parameters in Forsus group

		Mean	N	Std. Deviation	Mean diff	T	P value
Pair 1	SNA pre	80.1333	15	3.58303	-0.26	-0.71	0.48
	SNA post	80.4000	15	3.01899			
Pair 2	SNB pre	75.8667	15	3.62268	-1.30	-2.43	0.02 S
	SNB post	77.1667	15	2.81366			
Pair 3	ANB pre	4.0667	15	1.83095	0.63	1.24	0.23
	ANB post	3.4333	15	1.97183			
Pair 4	GOGN TO SN pre	26.5333	15	4.99809	-2.86	-3.89	0.002 HS
	GOGN TO SN post	29.4000	15	4.40454			
Pair 5	ANS ME pre	60.2667	15	5.62478	-4.20	-2.88	0.01 S
	ANS ME post	64.4667	15	7.83642			
Pair 6	MAX LENGTH pre	88.6000	15	4.17133	-0.83	-2.42	0.03 S
	MAX LENGTH post	89.4333	15	3.71708			
Pair 7	MAND LENGTH pre	110.4667	15	4.74893	-1.56	-1.88	0.08
	MAND LENGTH post	112.0333	15	4.73764			
Pair 8	Y ANGLE pre	64.7667	15	2.88386	-2.5	-1.85	0.08
	Y ANGLE post	67.2667	15	5.92171			
Pair 9	FAA pre	.5333	15	4.54920	0.00	0.00	1.00
	FAA post	.5333	15	3.44065			
Pair 10	U1 TO NA ANGLE Pre	30.9333	15	10.71359	2.93	1.06	0.30
	U1 TO NA ANGLE Post	28.0000	15	7.14143			
Pair 11	U1 TO NA LINEAR Pre	8.6000	15	3.43927	2.16	2.32	0.03 S
	U1TO NA LINEAR Post	6.4333	15	3.32129			
Pair 12	L1 TO NB ANGLE Pre	22.4667	15	10.80917	-7.53	-2.39	0.03 S
	L1 TO NB ANGLE Post	30.0000	15	8.60233			
Pair 13	L1 TO NB LINEAR Pre	4.8333	15	3.49319	-1.8	-1.64	0.12
	L1 TO NB LNEAR Post	6.6333	15	2.56673			
Pair 14	IA Pre	119.3333	15	21.16151	3.20	0.54	0.59
	IA Post	116.1333	15	20.19146			
Pair 15	S LINE TO U LIP Pre	2.6000	15	1.94753	0.63	2.52	0.02 S
	S LINE TO U LIP Post	1.9667	15	1.83679			
Pair 16	S LINE TO L LIP Pre	1.8000	15	2.70449	-1.60	-3.36	0.005 HS

	S LINE TO L LIP Post	3.4000	15	2.19740			
Pair 17	NA Pre	91.9333	15	15.75013	1.26	0.29	0.77
	NA_Post	90.6667	15	14.04415			

Table 3: Comparison of pre and the post skeletal parameters in BSSO group

		Mean	N	Std. Deviation	Mean difference	T	P value
Pair 1	SNA pre	81.5333	15	2.66905	1.2	2.55	0.02 S
	SNA post	80.3333	15	2.76887			
Pair 2	SNB pre	76.1000	15	5.18996	-2.5	-3.8	0.002 HS
	SNB post	78.6000	15	3.97851			
Pair 3	ANB pre	6.1000	15	2.90443	2.9	3.72	0.002 HS
	ANB post	3.2000	15	2.62406			
Pair 4	GOGN TO SN pre	25.5333	15	10.24602	-4.0	-3.01	0.009 HS
	GOGN TO SN post	29.5333	15	7.18000			
Pair 5	ANS-ME pre	62.0667	15	8.31064	-3.3	-3.43	0.004 HS
	ANS-ME post	65.4000	15	5.88946			
Pair 6	MAX-LENGTH pre	89.9333	15	6.29588	-1.06	-1.58	0.13
	MAX-LENGTH-post	91.0000	15	6.75066			
Pair 7	MAND-LENGTH pre	109.2000	15	13.61302	-6.4	-5.09	0.000 HS
	MAND-LENGTH-post	115.6000	15	11.14707			
Pair 8	Y-ANGLE-pre	65.6000	15	5.03984	0.6	0.83	0.42
	Y-ANGLE-post	65.0000	15	4.94253			
Pair 9	FAA-pre	-3.2000	15	6.32681	-0.86	-1.18	0.25
	FAA-post	-2.3333	15	4.40238			

Statistical test applied: Paired samples t test; HS – Highly significant at $p<0.01$; S – Significant at $p<0.05$

Table 4: Comparison of pre and the post dental & soft tissue parameters in BSSO group

Dental and soft tissue parameters		Mean	N	Std. Deviation	Mean difference	T	P value
Pair 1	U1 TO NA ANGLE Pre	29.2000	15	10.81137	0.8	0.36	0.72
	U1 TO NA ANGLE Post	28.4000	15	10.49354			
Pair 2	U1 TO NA LINEAR Pre	8.6000	15	4.89606	2.53	3.67	0.002 HS
	U1 TO NA LINEAR Post	6.0667	15	4.51136			
Pair 3	L1 TO NB ANGLE Pre	28.2000	15	9.47327	-1.6	-0.73	0.47
	L1 TO NB ANGLE Post	29.8000	15	6.24729			
Pair 4	L1 TO NB LINEAR Pre	6.6333	15	4.31139	0.96	1.08	0.29
	L1 TO NB LNEAR Post	5.6667	15	2.05866			
Pair 5	IA Pre	116.0000	15	14.13203	-3.06	-0.73	0.47
	IA Post	119.0667	15	9.06695			
Pair 6	S LINE TO U LIP Pre	3.8000	15	4.75395	1.9	2.29	0.03 S
	S LINE TO U LIP Post	1.9000	15	2.55091			
Pair 7	S LINE TO L LIP Pre	2.8333	15	4.11299	-0.13	-0.15	0.88

	S LINE TO L LIP Post	2.9667	15	2.78046			
Pair 8	NA Pre	93.2667	15	15.97975	-5.33	-1.23	0.23
	NA_Post	98.6000	15	13.32452			

Statistical test applied: Paired samples t test; HS – Highly significant at p<0.01; S Significant at p<0.05

Table 5: Overall comparison of pre & post -treatment skeletal, dental & soft tissue parameters in Twin block, Forsus & BSSO group

		N	Mean	Std. Deviation	F value	P value		Mean	Std. Deviation	F-value	P-value
SNA-pre	BSSO	15	81.5333	2.66905	1.77	0.18	SNA post	80.3333	2.76887	0.64	0.53
	Twin Block	15	79.1333	4.12080				79.2667	3.39046		
	Forsus	15	80.1333	3.58303				80.4000	3.01899		
SNB-pre	BSSO	15	76.1000	5.18996	0.80	0.45	SNB post	78.6000	3.97851	2.36	0.10
	Twin Block	15	74.4000	2.72029				76.1333	2.32584		
	Forsus	15	75.8667	3.62268				77.1667	2.81366		
ANB-pre	BSSO	15	6.1000	2.90443	3.50	0.03 S	ANB post	3.2000	2.62406	0.07	0.92
	Twin Block	15	5.2667	1.27988				3.4667	1.35576		
	Forsus	15	4.0667	1.83095				3.4333	1.97183		
GOGN-TO-SN-pre	BSSO	15	25.5333	10.24602	0.72	0.49	GOGN TO SN post	29.5333	7.18000	0.004	0.99
	Twin Block	15	28.7333	6.04113				29.3667	3.60786		
	Forsus	15	26.5333	4.99809				29.4000	4.40454		
ANS-ME-pre	BSSO	15	62.0667	8.31064	0.34	0.71	ANS-ME post	65.4000	5.88946	0.57	0.56
	Twin Block	15	60.5333	4.77892				63.0000	4.22577		
	Forsus	15	60.2667	5.62478				64.4667	7.83642		
MAX-LENGTH-pre	BSSO	15	89.9333	6.29588	1.45	0.24	MAX LENGTH post	91.0000	6.75066	1.42	0.25
	Twin Block	15	86.5000	5.94919				85.9333	12.38932		
	Forsus	15	88.6000	4.17133				89.4333	3.71708		
MAND LENGT-pre	BSSO	15	109.2000	13.61302	1.24	0.30	MAND LENGTH post	115.6000	11.14707	3.79	0.03 S
	Twin Block	15	105.4333	6.39438				107.5333	6.86468		
	Forsus	15	110.4667	4.74893				112.0333	4.73764		
Y-ANGLE-pre	BSSO	15	65.6000	5.03984	1.43	0.25	Y AXIS ANGLE post	65.0000	4.94253	1.40	0.25
	Twin Block	15	68.2000	8.17837				67.6667	2.58199		
	Forsus	15	64.7667	2.88386				67.2667	5.92171		

FAA-pre	BSSO	15	-3.2000	6.32681	2.11	0.13	FAA post	-2.3333	4.40238	2.42	0.10
	Twin Block	15	.5333	6.17445				-.8667	2.64215		
	Forsus	15	.5333	4.54920				.5333	3.44065		
U1-TO-NA-ANGLE-Pre	BSSO	15	29.2000	10.81137	0.54	0.58	U1 TO NA ANGLE Post	28.4000	10.49354	0.14	0.86
	Twin Block	15	32.9333	7.62952				26.9333	4.66701		
	Forsus	15	30.9333	10.71359				28.0000	7.14143		
U1-TO-NA-LINEAR-Pre	BSSO	15	8.6000	4.89606	0.36	0.69	U1NA LINEAR Post	6.0667	4.51136	0.20	0.81
	Twin Block	15	9.6333	2.83767				6.8667	2.00416		
	Forsus	15	8.6000	3.43927				6.4333	3.32129		
L1-TO-NB-ANGLE-Pre	BSSO	15	28.2000	9.47327	3.32	0.04 S	L1 TO NB ANGLE Post	29.8000	6.24729	1.25	0.29
	Twin Block	15	30.7333	6.04113				33.2667	4.75795		
	Forsus	15	22.4667	10.80917				30.0000	8.60233		
L1-TO-NB-LINEAR-Pre	BSSO	15	6.6333	4.31139	1.48	0.23	L1 TO NB LNEAR Post	5.6667	2.05866	2.14	0.13
	Twin Block	15	6.7667	2.12860				7.3667	2.10837		
	Forsus	15	4.8333	3.49319				6.6333	2.56673		
IA-Pre	BSSO	15	116.0000	14.13203	0.80	0.45	IA Post	119.0667	9.06695	0.17	0.83
	Twin Block	15	111.9333	11.05484				117.4667	7.65195		
	Forsus	15	119.3333	21.16151				116.1333	20.19146		
S-LINE-TO-U-LIP-Pre	BSSO	15	3.8000	4.75395	0.59	0.55	S LINE TO U LIP Post	1.9000	2.55091	0.53	0.59
	Twin Block	15	3.4667	1.64172				2.5667	1.23732		
	Forsus	15	2.6000	1.94753				1.9667	1.83679		
S-LINE-TO-L-LIP-Pre	BSSO	15	2.8333	4.11299	0.70	0.49	S LINE TO L LIP Post	2.9667	2.78046	0.13	0.87
	Twin Block	15	3.2333	3.25613				3.3333	2.50476		
	Forsus	15	1.8000	2.70449				3.4000	2.19740		
NA-Pre	BSSO	15	93.2667	15.97975	0.10	0.90	NA Post	98.6000	13.32452	1.48	0.23
	Twin Block	15	94.4000	12.10549				94.2000	10.12917		
	Forsus	15	91.9333	15.75013				90.6667	14.04415		

Statistical test applied: One Way ANOVA; S – Significant at $p<0.05$

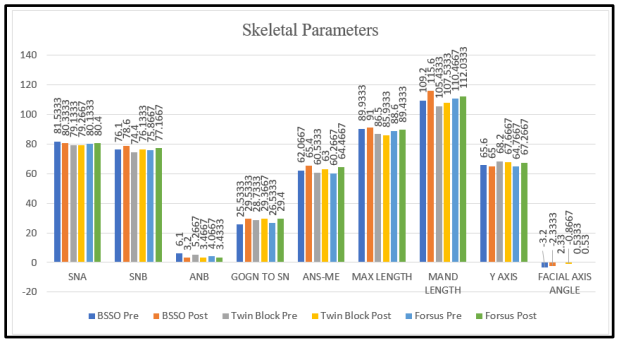

Figure 1: Overall comparison of pre & post treatment skeletal parameters in Twin block, Forsus & BSSO grou

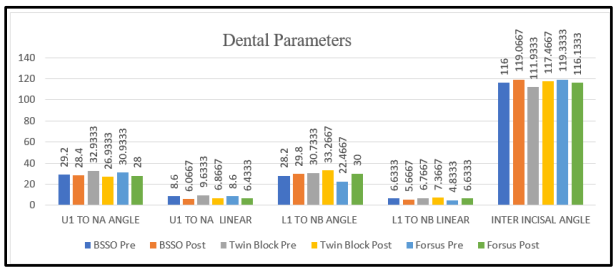

Figure 2: Overall comparison of pre & post treatment dental parameters in twin block, forsus & BSSO group

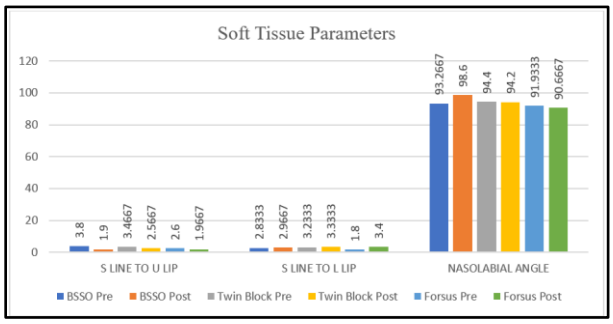

Figure 3: Overall comparison of pre & post treatment soft tissue parameters in Twin block, Forsus & BSSO group

6. Discussion

Functional appliances are a valuable means of correcting sagittal skeletal discrepancies caused by a retrognathic mandible. This study compared the treatment effects of three standardized Class II treatment modalities.[5]

One of the major concerns for functional appliance treatment is the treatment timing. Maximum treatment effects with functional appliances could be achieved when mandibular growth spurt was included in the treatment period (Baccetti et al., 2000). Thus, the treatment of the sample in question was undertaken in the active growth phase to elicit maximum skeletal response for favourable soft tissue adaptation.[6]

Gohilot et al. on comparing two fixed functional appliances, namely Herbst and Forsus, found that there was favourable reduction in facial profile convexity, improving aesthetics in both groups.[7]

Flores-Mir et al. in a systematic review on the soft tissue changes with fixed functional appliances in class II division 1 malocclusion stated that fixed functional appliances produce some significant statistical changes in the soft tissue profile. At the same time, they cautioned that the magnitude of the changes may not be perceived as clinically significant.[7]

Researchers have shown that TB therapy would result in greater advancement of mandibular soft tissues than Forsus FRD group but the overall influence on facial profile may not have significant clinical variation owing to the certain differences in the mechanism of action of two appliances. The soft tissue changes though indirectly reflect the treatment effect on hard tissues, and the treatment of nasal obstruction in growing patients result in a more normal pattern of dentofacial development.[6]

Traditionally, functional appliances formed an optimum treatment option for correction of mandibular retrognathism in Class II growing individuals. Forsus is a fixed functional appliance used to treat moderate Class II subjects and requires minimum patient compliance. Similar to other fixed functional appliances, reports revealed that Forsus was mainly effective in achieving dentoalveolar correction of Class II malocclusions. [9,10,11,12] But some findings reported minimal skeletal effects as well.[13,14] From previous studies, it appears that dentoalveolar changes may alter airway dimensions.[6,15] therefore, changes in airway dimensions could also be expected with treatment with Forsus appliance.

Orthognathic surgery (BSSO advancement) restores proper dental occlusion and facial harmony by modifying the position, shape, and size of the facial bones. Bone movement causes secondary positional and tensional changes in the attached soft tissues. These new soft tissue relationships lead to significant changes in the facial appearance and, in addition, in the entire pharyngeal airway space dimensions.[13]

Optimal treatment planning for maxillofacial surgery requires an understanding of the stability of the postoperative skeletal position and the soft tissue response to skeletal movement. The postoperative skeletal stability after BSSO for mandibular advancement was addressed earlier in a systematic review.[16]

The TB group exhibited statistically significant ($P < 0.05$) changes in all the studied parameters, namely, middle 1/3rd of face height, soft tissue LAFH, soft tissue profile angle, Holdaway angle, nasolabial angle and mentolabial sulcus angle while Forsus FRD group did not show significant change in soft tissue chin thickness and middle 1/3rd of face height between pre- and one-year post-treatment. The changes in the middle 1/3rd of face height in TB group were statistically significant but clinically insignificant due to small magnitude of change and may be associated with normal growth.[17]

Elfeky et al inferred that the mandibular incisor proclination and labial displacement occurs because of the teeth being part of the anchorage of the Twin block appliance. Whereas Al Jewair et al 31 reported significant increase in IMPA (5.3°) and L1-Apog (2.6 mm), which they explained was due to the clockwise rotation of the functional occlusal plane.[18]

By using Twin block, Forsus appliance and BSSO advancement surgery, have a significant effect on the mandibular length, SNB and mandibular plane as reported by earlier studies, but limited studies have been done to compare the skeletal, dental and soft tissue parameters of three commonly used modes of treatment for Class II patients with retrognathic mandible. Therefore, in this study evaluation of the skeletal, dental and soft tissue parameters of subjects treated with Twin block, Forsus and with a group of patients treated with BSSO surgical advancement surgery.

In the present study, these favorable mandibular growth increments were associated with a significantly greater mandibular advancement in the BSSO group than in the FRD & Twin block. Consequently, the BSSO group induced a more favorable correction in intermaxillary sagittal relationships than the Forsus and Twin block.

On comparing Twin block pre and post treatment values in relation to skeletal, dental and soft tissue parameters. There was highly significant increase in the SNB (1.7± 0.4), ANS-Me (2.5±0.5mm) and decrease in ANB (1.8±0.1°), and U1-to NA-angle (2.8±0.8°), U1-to NA-linear (6.8±3mm). S line to U-LIP values were also clinically significant (3.46±1.6 to 0.9±0.4mm).

On comparing Forsus pre and post treatment values in relation to skeletal, dental and soft tissue. There was highly significant increase in the Go-Gn -SN (2.9± 0.5mm), ANS-Me (4.4±2.2mm), and decrease in S line to L-LIP (0.39mm) and SNB (1.3± 0.8°), ANB (0.66±0.1°), Maxillary length (0.8±0.4mm), and U1-to NB-angle (7.6±2.2°), U1-to NA-linear (1.8±0.1mm), S line to U-LIP values were clinically significant (0.7±0.1mm).

On comparing BSSO pre and post treatment values in relation to skeletal, dental and soft tissue. There was highly significant increase in the ANS-Me (3.4±2.7mm), Go-Gn-SN (1±3.1°), and decrease ANB (2.9±0.7°), Mandibular length (6.4±2.4mm), SNA (2.5±1.2°). Increase in SNB values were also clinically significant (1.2±0.4°). There was highly significant decrease in the U1-to NA-linear (2.54±0.3mm). Decrease in S line to U-LIP values were also clinically significant (1.9±2.2mm).

On overall comparison the pre-treatment skeletal, dental and soft tissue parameters between twin block, Forsus and BSSO groups all the values were clinically insignificant except decrease in ANB by 2.04±1.07° in BSSO is more than in Forsus and decrease in L1-to NB-angle by 8.3±4.8° more in Twin block than in Forsus values were clinically significant as shown in table 5 depicted in **Figure 1**, **2 and 3.**

On overall comparison the post-treatment skeletal, dental and soft tissue parameters between twin block, Forsus and BSSO groups all the values were clinically insignificant except increase in mandibular length value by 8.1±4.3mm in BSSO is more than in Twin block was clinically significant as shown in table 5 depicted in **Figure 1**, **2 and 3.**

In the present study, it was observed that the sagittal jaw relationship was almost similarly significantly improved in all the groups by increase in SNB angle at the end of the treatment.

However, in our study significant higher improvement in the ANB and lower facial height both the groups Twin block (Group 1) BSSO advancement (group 3) with p value of at <0.01. But treatment shows significantly values than the Forsus group (Group 2) with a mean p value of 0.05.

The most prominent finding of the present study was increase in the mandibular plane angle in BSSO and Forsus group and reduced SNA with BSSO advancement.

Significant reduction of upper incisors proclination with reduced linear measurement of S-line to U lip in all the three groups. Upper lip was positioned backwards relative to S line in all the treatment groups. Lower lip was positioned forward relative to S line in Forsus group only. On post treatment overall comparison significant increase in mandibular length is seen in Group 2 and Group 3. Orthognathic interventions for correction of jaws deformities have an influence on the size and position of the surrounding soft tissues.[11] Stability of the results needs to be established by conducting long term studies.

The present study confirmed that there is a positive impact of Twin block, Forsus fixed functional appliance therapy as well as BSSO mandibular surgical advancement on the skeletal, dental and soft tissue. The BSSO advancement group showed better results as compared to Forsus and Twin block groups. The mandibular repositioning and the stretch of the muscles attached to it can be the probable cause of this improvement. BSSO advancement surgery seems to cause immediate and more mandibular repositioning as compared to the Twin block and Forsus fixed functional appliance treatment for Class II individuals.

7. Conclusion

The study measured the skeletal, dental and soft tissue changes brought about by the treatment with twin block, Forsus fixed functional treatment and BSSO mandibular advancement in Class II malocclusion subjects.

All treatment options cause statistically significant improvement in skeletal, dental and soft tissue parameters.

1. On comparing Twin block pre and post treatment values in relation to skeletal, dental and soft tissue parameters. There was highly significant change in the SNB, ANB, ANS-Me and U1-to NA-angle, U1-to NA-linear. S line to U-LIP values were also clinically significant.

2. On comparing Forsus pre and post treatment values in relation to skeletal, dental and soft tissue parameters. There was highly significant change in the Go-Gn - SN, S line to L-LIP and SNB, ANB, ANS-Me, Maxillary length and L1-to NB-angle, U1-to NA-linear, S line to U-LIP values were clinically significant.

3. On comparing BSSO pre and post treatment values in relation to skeletal, dental and soft tissue. There was highly significant change in the SNB, ANB, ANS-Me, Go-Gn-SN, Mandibular length. SNB values were also clinically significant. There was highly significant change in the U1-to NA-linear, S line to U-LIP values were also clinically significant.

Significant higher improvement in the ANB and lower facial height in both the groups Twin block (Group 1) BSSO advancement (group 3) with p value of at <0.01. But treatment shows significantly values than the Forsus group (Group 2) with a mean p value of 0.05.

It can be concluded from the present study that skeletal parameters improve more with BSSO advancement followed by Twin block as compared to Forsus fixed functional. There is more improvement in ANB, lower anterior facial height in all the three groups.

8. Source of Funding

None.

9. Conflict of Interest

None.

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