Original Article

EVALUATION OF DENTOALVEOLAR AND SOFT TISSUE CHANGES IN ADULT CLASS II MALOCCLUSIONS TREATED WITH DIFFERENT MODALITIES

Preethi Rajamanickam[1], Harish Babu[1], Ravindra Kumar Jain[1], Arthi Balasubramaniam[1]*

[1]Department of Orthodontics, Saveetha Dental College and Hospitals, Chennai, India. ravindrakumar@saveetha.com

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ABSTRACT

Class II correction demands various approaches depending upon the patient's growth potential, severity of malocclusion, and patient compliance. Aim is to evaluate the orofacial soft and hard tissue changes with three different treatment approaches namely enmasse distalization, AMO and Camouflage treatment. 45 adult skeletal class II patient records equally segregated into three clusters based on the treatment approach employed. Both pre-treatment and post-treatment lateral cephalograms were traced with FACAD software. Wilcoxon signed rank test for intragroup comparison and Kruskal Wallis test for intergroup comparison were done. Significant changes noted in the following: Max1-NA, Max1- APog, and Interincisal angle in all the 3 groups, Mand1-NB, in Group 1 and Mand1-APog in Group 3, Lower incisor-NB, Lower incisor-APog Line, Upper incisor-APog in all the 3 groups. Upper lip strain reduced in all groups significantly. Significant change was observed only in Group 3 in terms of upper lip length (p value <0.001), nasolabial angle (p value 0.01) and upper lip angle (p value 0.002). Interlabial gap showed significant change in all the 3 groups (p value <0.05). Intergroup comparison: Significant difference was noted in terms of upper lip strain, interlabial gap, upper lip angle and upper lip thickness. To conclude; Interlabial, Upper lip strain, upper lip angle and lower lip thickness reduced significantly in subjects treated surgically. Lower lip length increased significantly in the subjects treated with IZC anchorage. Upper incisor retrusion was highest in patients treated surgically and the lower incisor inclination reduced significantly in patients treated with Camouflage approach.

Key words: Class II malocclusion, Distalization, Surgical approach, Camouflage.

Introduction

Class II malocclusion is the second most common type of malocclusion in India and its prevalence ranges between 5% to 29% [1]. Treatment of skeletal class II division 1 malocclusion in adults can be accomplished with camouflage treatment involving premolar extractions or with surgical approaches in severe cases [2]. Several studies evaluating the effect of orthodontic treatment in different malocclusions on the facial profile have highlighted the relationship between the incisors and the lips [2-4] Soft tissue changes were assessed in patients after premolar extraction and significant upper and lower lip changes were reported [5]. Significant correlation between upper incisor retraction and upper lip position was noted in a study by Kurshid *et al*. in class II camouflage cases [2]. In a long-term follow-up study by Mihalik CA *et al*., class II malocclusion patients treated by camouflage treatment showed stable results of the skeletal landmarks with minimal relapse [6, 7]. A study by Kinzinger *et al*. compared the treatment outcomes of skeletal class II correction with camouflage, fixed functional appliance, and surgical approach and found a significant reduction in facial convexity with fixed functional therapy and surgical approach [8-10]. Also, according to recent research patient satisfaction with camouflage therapy is comparable to that of surgical mandibular advancement [6]. Thus with the minimal skeletal discrepancy, a camouflage approach maintaining the vertical dimension after extractions would serve as an appropriate treatment alternative for stable treatment results [6].

The introduction of skeletal anchorage using dental implants or mini-screws (MSs) has contributed to the increased use of this technique as it allows maxillary retraction or distalization to be carried out in a more controlled manner and largely independent of patient compliance [8]. Recently infrazygomatic crest (IZC) miniscrew anchorage has become an alternative treatment strategy for patients requiring orthognathic surgery [9], these anchorage systems provide absolute and stationary anchorage for various tooth movements eliminating the need for active patient compliance and with limited undesirable side effects. With total maxillary arch distalization using IZC anchorage, lip prominence was reduced by 2.3 and 3.5 mm in the upper and lower lips, respectively [10]. IZC anchorage along with anterior implants rendered full-arch distalization and intrusion of maxilla thereby correcting the gummy smile [11].

Previous studies have not reported on the comparison of lip and perioral changes following en masse distalization with IZC anchorage, Anterior maxillary osteotomies (AMO), and

camouflage involving premolar extractions. Since all these three approaches have been reported individually in the literature for correction of class II malocclusion and are also in practice, we framed this study for comparison of soft tissue changes by these three methods. Thus, the present investigation is focused to evaluate the soft tissue changes of the perioral region after skeletal class II correction with three different treatment approaches namely Infrazygomatic crestal implants(IZC), (AMO), and Camouflage.

Materials and Methods

This retrospective study was carried out at the department of Orthodontics, Saveetha Dental College, and Hospitals involving case records of skeletal class II subjects treated with either of the three modalities (Infrazygomatic crestal implants, Camouflage, Anterior maxillary osteotomy) over the past 5 years. Ethical approval was obtained from the Human Ethical Committee, Saveetha Institute of Medical Sciences. A total of 45 patient records were selected after applying the eligibility criteria and were divided equally into 3 groups depending on the treatment approach employed for class II correction.

The inclusion criteria for this study were as follows

1. Class II malocclusion subject's with full cusp Class II molar and canine relationship and complete set of treatment records with good quality pre and post-cephalograms.
2. Overjet greater than 7 mm

Exclusion criteria

1. Patients with missing or extracted teeth and any previous orthodontic treatment
2. Patients with systemic manifestations, TMD disorders, bone disorders

Group 1: Adult class II patients treated with camouflage (Extraction of maxillary first premolars and mandibular second premolars bilaterally) (N=15).
Group 2: Adult class II patients treated with en masse distalization with IZC anchorage (N=15).
Group 3: Adult class II patients treated surgically by AMO (N=15).

Pre (t0) and post-treatment (t1) lateral cephalograms of all included subjects were taken with the same equipment by the same operator at a constant magnification with lips in the rest position. The lateral cephalograms were taken in their natural head position under operator assistance. The post-treatment occlusion should be a well-interdigitated Class II or Class I molar with a Class I canine relationship and a markedly reduced overjet. All cephalograms were traced with Facad® (Version 3.12, Ilexis AB, Linköping, Sweden), by the same clinician and the following parameters were assessed **(Table 1)**.

Table 1. Soft tissue and hard tissue parameters assessed and their description

Hard tissue parameters	
Parameters	**Description**
Upper incisor–NA	Angle formed between long axis of upper incisor to the NA line
Upper incisor-APog	Formed between long axis of the upper incisor and the Point A-pogonion line
Lower incisor-NB	Angle formed between long axis of mandibular incisor and nasion-Point B line
Lower incisor-APog Line	Angle formed between long axis of mandibular incisor and Point A-pogonion line
Interincisal angle	Angle formed by intersection of long axis of maxillary and mandibular incisors
Max1-NA (mm)	Linear distance between the line passing through the long axis of the upper incisor and NA line
Mand 1-NB (mm)	Linear distance between the line passing through the long axis of the lower incisor and NB line
Mand 1-A Pog	Linear distance between the line passing through the long axis of the lower incisor and the A-Pog line
Max 1-A Pog	Linear distance between the line passing through the long axis of the upper incisor and the A-Pog line
Soft tissue parameters	
Sulcus superior -E-line (mm)	Linear distance between Sulcus superior to E line
Sn-Pog'-Labrale superior (mm)	Linear distance between two lines Subnasale to soft tissue Pogonion and Sulcus superior to E line
Labrale superior-Eline (mm)	Linear distance between labrale superior to E line
Sn-Pog'-Labrale inferior (mm)	Linear distance between Sn-Pog line to Labrale inferior.
Labrale inferior-E line (mm)	Linear distance between Labrale inferior to E line
Sulcus inferior-E line (mm)	Linear distance between sulcus superior to E line
Upper lip length (mm)	Subnasale (Sn) to Upper lip inferior
Upper lip Thickness (mm)	Measured from a point 2 mm below the A point to the outer border of the upper lip.

Upper lip strain (mm)	Measured from the vermilion border of the lip to the labial surface of the maxillary central incisor
Upper lip angle	Angle formed between the True vertical line (TVL) passing through Subnasale and the line passing through subnasale and Upper lip anterior (ULA)
Interlabial gap (mm)	The distance between Stomion superius and Stomion inferius
Lower lip length (mm)	Measured from Lower lip superior(LLS) to soft tissue menton (Me')
Lower lip thickness (mm)	Distance from incisal edge of maxillary central incisor to the vermilion border of the lower lip.

Statistical analysis

Statistical analysis was performed with SPSS software version 23. The power of this study was estimated with G*Power software 3.0. The sample size was calculated from the study article by Kenzinger *et al*. comparing skeletal and dentoalveolar changes in camouflage orthodontics, dentofacial orthopedics, and orthognathic surgery for class II correction. The level of significance was set up to be 0.05.

The Shapiro-Wilk test was performed to test the normality. The soft and the hard tissue changes between the three groups were analyzed with the Kruskal Wallis test and intragroup comparison was done using the Wilcoxon signed rank test.

Results and Discussion

The mean, SD, and mean difference of each group and the level of significance (p-value) for the Kruskal Wallis test (intergroup comparison) and Wilcoxon signed rank test (intragroup comparison) were tabulated in **Table 2**. The obtained data was found to be non-parametric with the Shapiro-Wilk test.

Table 2. Data gained for hard and soft tissue variables, pre treatment (t0), post treatment (t1), difference between them, SD and p-value (Wilcoxon signed rank test performed for intragroup comparison Kruskal Wallis test for intergroup comparison).

Parameter	Time point	Group 1 (Camouflage) Mean+/-SD	MD	P value	Group 2 (IZC) Mean+/-SD	MD	P value	Group 3 (AMO) Mean+/-SD	MD	P value	Intergroup comparison (p value)
Hard Tissue Parameters											
Interincisal angle(°)	T0	109.2+/-2.0	10.9	<0.001*	112.6+/-8.1	8.3	0.01*	110.9+/-3.8	5.2	0.01*	<0.001*
	T1	120.1+/-7.6			120.9+/-3.6			116.1+/-8.7			
Max1-NA(°)	T0	34.5+/-3.5	-10.4	<0.001*	35.1.2+/-2.5	-10	<0.001*	36.2+/-2.6	-9.8	0.001*	0.05
	T1	24.1+/-4.6			25.1+/-5			27.4+/-7.5			
Max1-NA(mm)	T0	9.9+/-1.5	-4.3	<0.001*	8.7+/-2.7	-3.1	<0.001*	8.9+/-3.5	-4.4	0.001*	0.05
	T1	5.6+/-1.1			5.6+/-2.1			4.5+/-2			
Max1-APog(°)	T0	31+/-5.4	-2	<0.001*	35.1+/-3	-1.2	<0.001*	36.8+/-3.9	-7.3	0.001*	<0.001*
	T1	29+/-5.2			33.9+/-4.4			29.5+/-4.9			
Mand1-NB(°)	T0	31.4+/-3	-3.2	0.01*	30.2+/-8.4	1.7	0.2	35.5+/-1.5	2.4	0.2	0.5
	T1	28.8+/-1.9			31.9+/-6.1			37.9+/-6.7			
Mand1-APog(°)	T0	25.6+/-2.4	-3.9	0.1	22.3+/-3.9	1.5	0.2	30.2+/-1.3	4.9	0.01*	0.01*
	T1	21.7+/-3.4			23.8+/-8.1			25.3+/-7.4			
Mand1-NB(mm)	T0	6.4+/-0.2	-0.4	0.06	6.3+/-1.2	0.4	0.001*	7.4+/-1.1	2.1	0.001*	0.001*
	T1	6+/-1.8			6.7+/-1.9			9.5+/-1.7			
Mand1-APog Line(mm)	T0	2.6+/-0.8	-0.7	0.06	1+/-1.1	2.9	0.001*	2.7+/-1.5	-1	0.001*	0.001*
	T1	1.9+/-1			3.9+/-2			3.7+/-0.4			
Max1-APog(mm)	T0	11.2+/-4.6	-4.3	0.001*	7.6+/-2.5	0.3	0.2	14.1+/-3.7	-7.4	<0.001*	<0.001*
	T1	6.9+/-0.8			7.9+/-2.4			6.7+/-1.9			
Soft Tissue Parameters											
	T0	-4.8+/-4.2	-1.6	0.06	-4.1+/--4	-3.5	0.001*	-7.3+/-1.5	-1.9	0.01	0.5

Sulcus superior -E-line (mm)	T1	-6.4+/-1.1			-7.6+/-2.2			-9.2+/-0.9				
Sn-Pog'-Labrale superior(mm)	T0	3.4+/-1.6	-0.3	0.1	3.5+/-2.2	0.4	0.7	5.4+/-4.4	1.3	0.01	0.05
	T1	3.1+/-1			3.9+/-0.3			4.1+/-1.3			
Labrale superior-E line(mm)	T0	-1.9+/-1.6	-3	0.001*	-2+/-2	-0.8	0.2	0.06+/-4.1	-2.6	0.2	0.3
	T1	-4.9+/-3.5			-2.8+/-2.5			-2.6+/-1.4			
Sn-Pog'-Labrale inferior (mm)	T0	3.9+/-2.3	-2.7	0.001*	3.1+/-2.6	-0.8	0.001*	4.8+/-3.8	-1.8	0.01	<0.001*
	T1	1.2+/-1.6			2.3+/-2.8			3+/-3.3			
Labrale inferior-E line(mm)	T0	0.6+/-0.5	-0.4	0.06	0.6+/-3.4	-2.1	0.001*	0.7+/-3.8	-1.6	0.01	0.1
	T1	0.2+/-3.4			-1.5+/-3.7			-0.9+/-3.4			
Sulcus inferior-E line(mm)	T0	-6.2+/-2.9	-2.9	0.001*	-5+/-3.3	-1	0.05 sig dec??	-3.8+/-2.4	-3.4	0.001*	<0.001*
	T1	-9.1+/-5.1			-6+/-3.7			-7.2+/-2.3			
Nasolabial angle	T0	91.9+/-18.4	3.8	0.01	89.9+/-17.9	3.3	0.01*	87.3+/-10.3	5.5	0.01*	0.3
	T1	95.7+/-7.4			93.2+/-12.5			92.8+/-9.3			
Labiomental angle	T0	112.5+/-11.9	3.2	0.06	103.7+/-4.4	-1.7	0.7	115.8+/-11.7	-1.2	0.2	0.4
	T1	115.7+/-5.8			102+/-11.7			114.6+/-8.3			
H angle	T0	14.4+/-3.5	-2.2	0.5	18.6+/-3.4	0.1	0.7	17.3+/-3.1	-0.7	0.7	<0.001*
	T1	14.2+/-5.7			18.7+/-3.5			16.6+/-1			
Z angle	T0	59.5+/-3.2	2.1	0.06	64.8+/-17.6	3.3	0.01	69.7+/-12.5	2.5	0.7	0.4
	T1	61.9+/-8.9			68.1+/-16.8			72.2+/-9.3			
Upper lip length	T0	21.5+/-1.9	-0.1	0.7	20.02+/-2.04	0.58	0.3	21.4+/-1.6	2.7	0.001*	0.00*
	T1	21.4+/-2.1			20.6+/-2.06			24.1+/-1.4			
Upper lip thickness	T0	11.5+/-0.5	0.3	0.1	12.6+/-2.8	-1	0.2	11.6+/-1.8	0.6	0.3	<0.001*
	T1	11.8+/-0.6			11.6+/-2.7			12.2+/-3.07			
Strain factor	T0	2.9+/-1.9	-1.4	0.001*	3.2+/-1.7	-1.4	0.001*	5.6+/-2.4	-3.9	0.001*	<0.007*
	T1	1.5+/-2.5			1.8+/-2.1			1.7+/-1.1			
Upper lip angle	T0	15.1+/-15.2	-0.3	0.6	12.6+/-5.1	-1.56	0.3	21.1+/-5.7	-4.6	0.002*	0.015*
	T1	14.8+/-13.9			11.04+/-3.9			16.5+/-4.6			
Interlabial gap	T0	5.1+/-1.7	-1.9	0.01*	6.8+/-4.03	-2.7	0.001*	11.3+/-2.2	-6	0.001*	0.00*
	T1	3.2+/-1.9			4.1+/-1.8			5.3+/-1.07			
Lower lip length	T0u	38.4+/-3.3	0.7	0.025	41.5+/-6.04	1	0.001*	46.7+/-4.7	-0.1	0.05	0.15
	T1	39.1+/-2.7			42.5+/-5.8			46.9+/-4.7			
Lower lip thickness	T0	13.2+/-1.08	-0.4	0.2	13.8+/-2.6	-1.2	0.1	14.08+/-4.6	-0.18	0.3	0.2
	T1	12.8+/-1.2			12.6+/-1.6			13.9+/-4.5			

Hard tissue parameters

On intragroup comparison (T0 - T1), statistically significant changes were noted in the following angular measurements: Max1-NA, Max1-APog, and Interincisal angle in all the 3 groups. The following linear measurements - Mand1-NB (Group 1) and Mand1-APog (Group 3) lower incisor-NB, lower incisor-APog Line, Upper incisor-APog (all groups) showed a statistically significant change (p-value <0.05) **(Table 2)**.

On intergroup comparison at T1, statistically, significant differences were noted in the following parameters: Interincisal angle, Max1-NA(linear and angular), Max 1-APog (linear and angular), Mand1-NB(linear), Mand1-APog (linear and angular) showed significant differences, whereas Mand1-NB(angular) did not show any significant changes.

Soft tissue parameters

On intragroup comparison (T0 - T1), statistically significant changes were noted in the following soft tissue measurements: Upper lip strain and interlabial gap (all three groups), nasolabial angle, upper lip length and upper lip angle (Group 3)(p-value <0.05).

On intergroup comparison statistically significant changes in upper lip strain, interlabial gap, upper lip angle, and upper lip thickness were noted **(Table 2)**.

On intragroup comparison (T0 - T1), statistically significant changes were noted in the following angular measurements: Max1-NA, Max1-APog, and Interincisal angle in all the 3 groups. The following linear measurements - Mand1-NB (Group 1) and Mand1-APog (Group 3) lower incisor-NB, lower incisor-APog Line, Upper incisor-APog (all groups) showed a statistically significant change (p-value <0.05) **(Table 2)**.

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Soft tissue parameters

On intragroup comparison (T0 - T1), statistically significant changes were noted in the following soft tissue measurements: Upper lip strain and interlabial gap (all three groups), upper lip length, nasolabial angle, and upper lip angle (Group 3)(p-value <0.05).

On intergroup comparison statistically significant changes in upper lip strain, interlabial gap, upper lip angle, and upper lip thickness were noted between groups **(Table 2)**.

Factors to be considered for correction of class II malocclusions include vertical dimensions, dentoalveolar protrusion, lip competency, facial convexity, and occlusion. The condition may be congenital, developmental, or acquired due to illness, trauma, or environmental factors [12-14]. It may also substantially limit the ability to engage in a major life activity. In addition to the absence of disease, the concept of quality of life also includes the presence of physical, mental, and social wellbeing [12, 13, 15, 16]. severe malocclusion often is associated with functional limitation, pain, and social disability that affects the emotional and social well-being of young male and female adolescents. In adult patients, different treatment approaches for class II malocclusion include camouflage treatment involving premolar extractions, molar distalization, and orthognathic surgery and it is very important to assess and quantify hard tissue and soft tissue changes with these approaches in order to plan a tailored treatment approach, hence this study was taken up. In this study, all three approaches resulted in a clinically significant overjet reduction, maxillary incisor retrusion, nasolabial angle changes, and reduced lip protrusion at T1. On intergroup comparison of soft tissue changes, significant differences were noted for upper lip length, strain factor, upper lip thickness, interlabial gap, upper lip angle, and H angle with the most favorable changes noted in patients who underwent AMO. Significant differences in lower lip protrusion were noted between groups with maximum retrusion in subjects treated with camouflage and significant improvement in lower lip competency was noted in subjects who underwent AMO. The upper and also lower lip length increased in all the groups while the thickness of the lower lip decreased in all groups, upper lip thickness increased in subjects who underwent AMO. Mandibular incisor retraction was noted only in the camouflage group. Upper anteriors became upright at T1 more significantly in subjects who underwent AMO.

The results of this study are very much in agreement with the findings of the study by Kinzinger *et al*. who compared the hard and soft tissue changes in class II individuals with three different treatment approaches namely Camouflage, fixed functional appliance, and BSSO. It was observed that all three treatment approaches allowed a significant reduction in the overjet. The vertical changes such as lip length and other facial heights increased in the surgical group.

The changes in the lower and upper incisor inclinations are in agreement with the previous studies. The results of the study by Jo *et al*. in which a comparison between en masse distalization with modified C plate and anterior retraction with extractions was done showed maximum retraction of the incisors in the extraction group (5.3 mm) followed by distalization group (3.4 mm) [17, 18] which is coincident with the results of our study with mean values of 4.3 mm in the extraction group and 3.1 mm in the distalization group.

The interincisal angle reduced after treatment in all the 3 groups and agreed with the previous studies. Though not the same three groups were compared, the role of camouflage treatment in significantly reducing the lip procumbency was previously explained by a few authors [6, 19] who reported mean maxillary incisor retrusion of 5.27 mm and mean upper lip retraction of 2.03 mm, and the mean lower lip retraction of 1.23 mm. The amount of upper lip retraction achieved was greatest in Group 3(1.3 mm) followed by Group 2 (0.7mm), while for the lower lip maximum retraction was noted in Group 1 (2.7mm) followed by Group 3 (1.8mm)

The findings related to lip length changes in the camouflage group are in agreement with the previous studies by Tallas *et al*. and Rains and Nanda [20, 21]. Tallas conducted a study to predict the soft tissue changes with orthodontic camouflage treatment and found significant changes with upper incisor retraction of 6.7 mm, retrusion of the upper lip, the increase in the lower lip length, and the increased nasolabial angle. The lip length in the study by Tallas *et al*. increased by 3.4 mm and Nanda reported an increase of 0.6 mm whereas in our study the maximum increase achieved was 1 mm (AMO group). Tallas *et al*. stated the reasons for lip length increase to be longer lower lip before treatment, a greater amount of upper incisor crowns covered by the lower lip before treatment, and increased lower facial height post-treatment [21].

The nasolabial angle increased in all the 3 groups, but was statistically significant in Group 3. Nasolabial angle increased significantly in the surgical group and these results are in agreement with the previous studies [21-23]. Komal *et al*. studied four angular measurements in patients treated by anterior maxillary osteotomy and found a significant increase in the nasolabial angle post-surgery. Tallas reported the reasons for the larger increase in nasolabial angle to be: greater increase in hard tissue, lower facial height, the thicker soft tissue at subnasale before treatment, greater incisor retraction, thinner upper lip, and greater overjet pretreatment [21]. These results are not in agreement with Waldman *et al*. [24] who did not find any correlation between incisor retraction and nasolabial angle and also not with the ratios proposed by Lo and Hunter (1.6 degrees for each 1mm retraction of the upper lip) [24, 25].

Limitations and future scope

This was a retrospective study with less sample size confined to one particular geographical extent and population. Future studies to be done with a larger sample size with better standardization of pretreatment baseline data. Also, a gender-specific study should be formulated in the future for making it a study with greater clinical relevance.

Conclusion

1. The upper incisor inclination decreased in all three groups irrespective of the treatment approach employed. Upper incisor inclination showed the highest reduction in patients treated surgically.
2. The lower incisor inclination reduced significantly in patients treated with the Camouflage approach.
3. Lip retrusion was achieved in all three groups. Interlabial gap, Upper lip strain, upper lip angle, and lower lip thickness reduced significantly in subjects treated surgically when compared to other modalities.
4. Lower lip length increased significantly in the subjects treated with IZC anchorage.

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Conflict of interest: None

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Ethics statement: Ethical approval was obtained from the Institutional Ethical Committee, Saveetha Dental College, and Hospitals.

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