

## The Effect of Modified Lip Bumper on Subperiosteal Bone Growth in the Anterior Region of Mandible

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### Abstract

**Introduction:** The successful orthodontic treatment depends on elimination all factors that can cause the malocclusion. There are so many factors such as functional environmental factors. The excessive labial muscle activity is one of the important functional environmental factors that can lead to crowding in lower incisors and retrusion of upper incisors which causes narrow in lower dental arch. There are so many therapies to avoid this factor such functional appliances as Frankel regulator and lip bumper. The orthodontist often needs more than one approach in his/her treatment to achieve his/her goal. Since the orthodontist can use lip bumper with other orthodontic appliances especially fixed appliances, many studied was done to determine its effects on facial dental complex. The past studies were done on lip bumper which place in front of dental arch without extend to vestibular groove, so the results were not satisfy.

**Aim of the Study:** The aim of this study is to know if the modified lip pumper, which extend to deep point of anterior vestibule groove to do as Frankel appliance, can improve the labial activity and correct the associated malocclusion such as crowding and retrusion of incisors.

**Subjects:** The sample of this study contains 100 patients (46 male. 54 female), an age average 11.9 years, have class II malocclusion.

**Methods:** It was divided upon type of bite in two groups (normal bite, deep bite), then each group divided in two as their orthodontic treatment, group A treated by modified lip bumper with another orthodontic appliance. Group B treated without lip bumper.

**Results:** The results of the modified lip bumper are inclusions of a motivation the periosteum to formation the bone, improvement lower incisors position and their relation with upper incisors by occur bodily movement of lower incisors, uprighting and distal movement of first lower molars, improvement labial muscle activity, increase dental arch dimension and elimination the crowding, in addition to slight improvement in sagittal jaws relation which lead to improve the facial profile especially lip profile.

**Keywords:** Lip Bumper; Subperiosteal Bone Growth; Mandible

### Introduction

The aim of orthodontic treatment is to achieve the aesthetic and functional perfection of the facial dental complex. This requires knowledge of all the factors that may lead to disturbances which could impair this perfection and the factors that work towards the goal of the treatment, thus eliminating or avoiding any undesirable factor (functional disorders, abnormal oral habits), and the use of preventive procedures against anything that could impair the development of the facial dental compound.

In general, most scientists believe that there are several reasons for malocclusion, the most important is which related to facial growth, since the growth of the facial dental complex is subject to genetic and environmental factors (especially the function), the scientists differed in the role of each these factors affected the development of facial dental complex.

Genetics plays a role in the development of the facial dental complex and therefore may be considered as a factor for the occurrence of malocclusion either directly or indirectly.

The influence of environmental factors varies from the forces and its influence during the growth and development of the face, jaws and teeth. It has a significant relationship to physiological activity, which is manifested by adapting environment to the function.

The normal function plays an important role in the development and normal growth of the craniofacial complex and any dysfunction in functional activities such as oral breathing and infant swallowing will cause the malocclusion [4].

The bad muscular activity (sucking finger, lip biting, lip sucking and tongue thrusting) is the most common environmental factors that play an important role in the deviation of the growth and development of the craniofacial complex from its normal way [13]. Since the position and stability of the teeth are affected by the balance between the surrounding muscular forces so [26-31] any defect in this balance due to bad functional activity such as lip sucking, lip biting or tongue thrust will break this balance and change the natural environment for the development of teeth and jaws, which will result in malocclusion [6,12,14-17].

Therefore, different therapeutic techniques based on variable principles have developed depending on the concept of the pathogenesis of the facial dental disorders, the genetic theory holds that the only possibility treatment for malocclusion is to perform an alveolar dental compensation or at best inhibit the growth. Other opinions that depend on environmental factors as a cause of malocclusion, such as Moss who said that the shape adapt to function and the effect of muscles is the main causal basis and it is the environmental factor in the development of malocclusion, therefore modifying this factor can stimulate the growth of one jaw, stop the growth or adjust the direction of the growth in the other jaw.

Many scientists have pointed out that the function varies per environmental conditions and that some aspects of the function are inherited, especially muscle attachments, muscle shape and soft tissue, these factors are called epigenetic factors, according to Vanlimborgh 1968, so it is possible to direct the genetic influence by function therefore we can adjust the growth within the boundaries of the genetic model.

Depending on the theory of the functional matrix of Moss, Frankel [11] confirms that the dental arch takes their final form through the balance of forces outside and inside the mouth, and therefore any imbalance in one of these forces will lead to disorder, whether an increase in the effectiveness of the tongue which will push the

incisors labially or increase in the efficiency of the lip that leads to lingual or palatal inclination of the incisors. This plays a role in Frankel's treatment philosophy, so he depended on periosteal muscle tension as well as remove undesirable effect of muscles to treat malocclusion [9]. Frankel proves the possibility of bone formation through muscle tension, therefore in cases of retrude the mandible associated with a horizontal growth pattern, he put oral pads in his FR-II to remove the effect of the lip from the dental arch and to create a periosteum tension through the constriction of the mentalis and orbicularis oris muscles which induce bone deposition on the anterior edge of the alveolar process of the mandible. The removal of the effect of the lip, according to Frankel, helps to reduce malocclusion.

Frankel was not the first one who use shields, preceded by Kraus [24], which adopted the same philosophy in his book in 1956 and has used oral screen technology for several years in many devices such as Bionator. Frankel also pointed out that the effect of buccal and labial shields is not limited to preventing the abnormal action of the muscles and allowing the teeth to erupt outward and downward [23], but also by extending the shields to the depth of the oral groove which put the periosteum tissue under the influence of tensile forces and lead to the bone formation. The experiments of Enlow [8], Hoyt and Moffett proves that the periosteum tension can show an increase in the effectiveness of bone formation in adjacent bone structures. Several cephalometric images of many cases treated with Frankel have shown apical basal expansion [11]. A study by Graber and his colleagues, sponsored by the National Institutes of Health (NIH) and the American Dental Association (ADA) (an unpublished 1998 study) showed that vestibular shields stimulated the vestibular bodily movement of the posterior teeth compared to the control sample. In contrast, some shields were applied to reduce the effect of the lip on the dental arch in the orthodontic treatment such as fixed devices.

The Oral Shield or oral screen was considered the starting point in the development of lip bumper which was first described by James [21] in 1913. Lip Bumper has been used in many orthodontic treatments for several purposes such as control the support, maintain space, improve the effectiveness of oral muscles, reduce crowding in the dental arch, distalization the first molars, increase the circumference of the dental arch, and correct the bad oral habits [1,2,5,7,8,22]. Scientists have shown several benefits from using Lip Bumper, including reducing the need for extraction, decreasing the time of orthodontic treatment, and maintaining the stability of orthodontic treatment results.

### Aim of the Study

The aim of the Study is to determine the effect of Modified Lip Bumper on the subperiosteal bone growth in the anterior area of mandible.

### Materials and Method

#### Materials

**Design:** Quasi experimental study.

**Setting:** The study was carried out in the clinics of the Department of Orthodontics at the Faculty of Dentistry, University of Damascus, Damascus University.

#### Subjects

The study subjects amounted to 100 patients (46 male, 54 female), an age average 11.9 years, who came to the mentioned clinic during the research period, and fulfilling the following criteria: diagnosed as having a skeletal class II malocclusion causing by re-trude of mandible.

#### Tools:

1. **Clinical examination:** It was done to the patients via special form (form 1) which design by researcher to serve the

study and includes the patient medical history, type of feeding, sickness, trauma, the face` shape, eruption of primary teeth, eruption of the permanent teeth, labial nasal angel, labial mentalis fold, the facial height and the dental formula. After clinical examination finished the impression of two jaws was made to make dental cast before and later after the treatment.

2. **Lab work:** It was included the lab steps of making Modified Lip Bumper (Figures 1).
3. **Study dental cast:** The study model was done per form 2, which design to serve our study and includes the amount of overjet, overbite, molar relationship, canine relationship, the width between lower canine, premolar and molars, Pont analysis, the length of anterior arch according to Korkhaus, the size of circumference according to LundStrom.
4. **Radiography:** Panoramic radiograph was done to all patients before the treatment. Lateral cephalometric radiograph was done to all patients before and after the treatment. The cephalometric analysis was done depending on various analysis such as Lingshtrom, Jarabak, Bjork, Steiner, and Dawns including 15 angels and 30 liner measurements as shown in form 3 and figure 2.

**Figure 1:** The lab steps of making modified lip bumper.



**Figure 2:** The cephalometric landmarks.

**Methods**

The sample was divided upon type of treatment in two groups:

- **Treatment group:** It consists of 50 patients (20 male, 30 female), an age average 12.05. They treated by Modified Lip Bumper and other orthodontic appliances. Depending on the type of growth pattern this group was divided to two groups, group A has normal bite or non-skeletal deep bit (11 male, 14 female) age average 11.5 year, while group B has skeletal deep bite or covered bite (9 male, 16 female), age average 12.6 year.
- **Control group:** It consists of 50 patients (26 male, 24 female), age average 11.7 year. They treated orthodontically without modified lip bumper. It used as a control group to determine what kind of results we owned from using modified lip bumper. It is also divided to two groups depending on the type of growth pattern, group A has normal or non-skeletal bite (19 male, 6 female), age average 11.10 year, and group B has a skeletal deep bite or covered bite (7 male, 18 female), age average 12.3 year.

Later, 5 patients were excluded from treatment sample because they weren't cooperate in wearing the modified lip bumper. Only 34 patients were considered as a control sample.

**Modified Lip Bumper**

The device is designed by the researcher and manufactured by her in the lab of Orthodontic Department at the Damascus University, and depends mainly on the deep placement of lip bumper` labial pads in the vestibular groove of the lower anterior region, so the goal of the research is to test the effectiveness of this modified device in causing skeletal and alveolar dental changes in the anterior region of mandible.

**Modified Lip Bumper consists of three parts (Figure 3)**

**Two metal parts:**

1. The orthodontic bands, which are fixed on the first molars and contain a vestibular tube.
2. Stainless steel wire diameter 0.0045 "(1 mm) divided into three parts: two side wires, each of which extends from the

acrylic shield in the front to end with a U-shaped mesial to the vestibular tube of the orthodontic band, and a front wire extending between the two acrylic pads.

**Figure 3:** The different in design between lip bumper and modified lip bumper.

An acrylic part of two acrylic pads which placed in the front area, extending to the depth of the oral vestibular groove and away 1 mm from the gingival tissue in sagittal direction.

The action of Modified Lip Bumper's mechanism depends on the change of the oral muscles on the teeth and thus their effects allowing for increased efficiency of the tongue forces, which works to break the muscle balance in favor of the lingual muscles, thus causing the frontal and lateral expansion of the dental arch [25], the Modified Lip Bumper is created new muscular system balance inside the mouth which applied on teeth and bone support. Over time, the teeth try to adapt to this new system to rebalance the muscle forces, which occurs rapid tooth movements at an early stage and then begin to decline when the dental compound adapt with the appropriate situation of the new muscle balance.

### Statistical Analysis

The statistical study was conducted to reach the mean, standard deviations, minimum and maximum values for each group of study groups before and after treatment for the treatment group as well as in the control sample before and after six months. The significant differences between all variables in the previous comparisons were calculated by using t-test at two levels of significance  $P = 0.01$ ,  $P = 0.05$ .

## Results

### Treatment group versus control group

It has been shown an improve in the sagittal relationship between upper and lower jaws of treatment group when it compared with control group where ANB angel decreased about  $0.5^\circ$ .

It has been an improve in the vertical relationship between upper and lower jaws of treatment group when it compared with control group where S Ar Go angel increased about  $0.56^\circ$ , the distance [N Me] increase by 3.61 mm and the distance [S Go] increased by 2.41 mm.

It has been an improvement in the inclination of lower incisors in the treatment group which causing an improvement in the sagittal and vertical relationship between upper and lower incisors and decrease the over bite when it compares with control group. The coordinates of point Id increased about 2.7 mm horizontally and 3.09 mm vertically, while the coordinates of point B increased about 2.25 mm horizontally and 3.18 mm vertically, and the coordinates of point Pog increased 1.87 mm horizontally and 3.43 mm vertically, while the coordinates of point Gn increased 1.78 mm horizontally and 3.46 mm vertically. In addition to decreasing in the overjet by 1.49 mm and overbite by 1.68 mm.

It has been shown an increase in the length of mandible in the treatment group when it compared with control group, which indicated by increasing in the distance [B Co'] by 3.02 mm and the distance [Gn Co'] by 3.1 mm.

It has been shown an improvement in the position of mandibular first molar in the treatment group when it compared with control group. It was indicated by the increasing of the value of angel 6: Go-Me by  $4.47^\circ$ , and increasing of coordinates of point m by 1.88 mm horizontally and 1.4 mm vertically.

There was an improvement in the soft tissue profile of lower face in the treatment group when it compared with the control group, where the upper lip retrude by 0.75 mm in its relation with Ricketts line, and the lower lip protrude by 0.09 mm in its relation with Ricketts line. There was also an increasing in the coordinates of point Sn by 1.91 mm horizontally and 1.5 mm vertically, an increasing of coordinates of point Ls by 2.09 mm horizontally and 2.04 mm vertically, an increasing in the coordinates of point St by 2.07 mm horizontally and 1.64 mm vertically, an increasing in point Li by 2.77 mm horizontally and 2.04 mm vertically. An increasing in the coordinates of point Sm by 3.33 mm horizontally and 3.02 mm vertically, and an increasing in the coordinates of point Pog' by 2.46 mm horizontally and 3.02 mm vertically.

There was an improvement in the dimension of dental arch in the treatment group when it compared with control group, where there was an increasing in the lower canine width by 1.79 mm, an increasing in the lower premolars width by 2.53 mm and an increasing in the lower molars width by 3.51 mm. There was an increasing in the size of basal bone in the anterior are by 2.24 mm, and an increasing in the total basal bone by 6.63 mm.

The cephalometric values of the treatment group									
Variable	Before the treatment (n = 45)				After the treatment) n = 45)				Sig.
	X	SD	Max	Min	X	SD	Max	Min	
SNA	80.42	3.27	87	72	80.72	3.4	88	72	-
SNB	74.99	3.06	81.5	66	75.77	3.06	82	66	-
ANB	5.43	1.66	9.5	2	4.96	1.64	8	1	-
N-S:Ar	127.43	4.53	141	119	127.51	7.76	143	117	-
S Ar Go	144.74	5.52	155	133	145.14	6.34	155	129	-
Ar Go Me	124.07	5.99	138	113	123.79	6.56	140	112	-
Bjork	396.24	4.68	407	386.5	396.38	4.81	408.5	386.5	-
N-S: Gn	70	3.65	81	63	70.23	3.64	82	63	-
N-S:Go Me	36.07	4.61	47	26.5	36.38	4.87	48.5	26.5	-
B	25.21	4.64	38	17.5	24.41	4.98	39.5	17	-
[Go Me]	69.58	4.72	81	60	71.6	4.79	81	62	-
[N Me]	116.33	6.54	134	105	119.97	6.59	133.5	107	+
[S Go]	73.39	4.79	85.5	65	75.8	4.86	88	67	+
Jarabak %	63.21	3.2	69.8	57	63.29	3.27	69.84	56.15	-
Id H	56.19	5.93	71	38.5	58.87	6.61	73.5	37	-
Id V	85.36	5.17	99	75	88.32	7.78	97.5	78.5	+
B H	51.49	6.62	65.5	31	53.52	6.91	67	29	-
B V	90.84	5.54	106	80.5	93.87	5.25	106	84.5	+
Pog H	48.86	7.1	64	26	50.64	7.43	65	24.5	-
Pog V	105.64	6.65	124	92.5	108.94	6.42	124	96	+
Gn H	46.49	7.34	63	23	48.11	7.69	63.5	21	-
Gn V	111.06	6.67	129	98	114.68	6.57	129	101	+
[B Co`]	91.07	5.34	101	80	94.07	5.2	103	83.5	+
[Gn Co`]	103.11	6.27	116	90	106.21	6.27	117.5	92.5	+
I: N-S	99.89	10.57	118	62	102.88	6.87	118	85	-
I: Spp	68.53	8.81	98	52.5	66.04	6.56	82	53	-
i: Go Me	93.91	6.92	107	78	94.58	6.46	105	80	-
I: i	129.4	12.37	169	105.5	126.01	9.08	147	111	-
6: Go Me	9.78	4.66	20	0	14.09	5.18	25	3	++
m H	32.54	5.29	47.5	20.5	34.33	5.92	50	21	-
m V	73.98	4.43	84	65	75.38	4.93	86.5	66.5	-
U Lip	-0.43	2.41	5.5	-5	-0.97	2.59	4.5	-6	-
L Lip	0.76	2.78	7.5	-6	0.84	3.11	8	-5.5	-
Sn H	78.36	6.05	96	62	80.2	6.2	98.5	61.5	-
Sn V	59.02	3.89	66	51.5	60.34	3.87	69.5	53	-
Ls H	79.23	6.22	95.5	62	81.08	6.71	97.5	60.5	-
Ls V	71.26	4.79	80	60	73.32	4.67	83	64.5	-
St H	71.65	6.04	88.5	55.5	73.68	6.92	90.5	52.5	-
St V	79.66	4.29	88.5	70	81.01	4.82	91	71.5	-
Li H	71.26	6.8	89	52.5	73.98	7.22	90	51.5	-
Li V	90.28	6.03	105	78	91.87	5.91	103.5	80.5	-
Sm H	61.7	6.51	78	43.5	65.08	7.25	82.5	43	+
Sm V	94.47	5.75	109	84	97.36	6.23	111	85	+
Pog` H	61.36	7.36	82	42	63.68	7.93	84	40	-
Pog` V	105.94	6.3	123.5	95	109.03	6.6	123	95	+

**Table 1:** Shows changes in the lateral cephalometric image of the treatment group and the significant differences before and after treatment.

X Average Sig. +P <= 0.05, SD: Standard Deviation; Sig. ++ P <= 0.01, Max: Maximum; non-Sig. -Min: Minimum

The values of dental cast study of the treatment group									
Variable	Before treatment (n = 45)				After treatment (n = 45)				Sig.
	X	SD	Max	Min	X	SD	Max	Min	
Over jet	5	2.25	9	0	3.51	1.76	8	0.5	++
Over bite	4.46	1.35	8.5	1.5	2.78	1.18	6	0.5	++
C - C	27.19	2.7	39	23	28.64	1.89	34	24	++
P - P	37.16	2.25	45	31	39.68	2.32	47	34	++
M - M	46.78	3.28	57	39	50.31	3.51	59	42	++
n P - P	39.7	2.85	47.5	32.5	39.7	2.85	47.5	40.6	
n M - M	49.56	3.63	59	40.6	49.58	3.54	59	40.6	
n P - e P	-2.24	2.8	5.5	-7.5	0.26	2.79	7.5	-4.5	++
n M - e M	-2.75	3.87	5.4	-12	0.83	3.65	7.4	-6	++
n LU	11.99	2.71	18	5	11.87	2.62	18	5	
n LL	9.99	2.71	16	3	9.88	2.55	16	3	
LL	8.11	2.38	14	2	10.14	2.62	18	6	++
n LL - e LL	-1.94	2.22	2	-8	0.42	2.24	5	-6	++
Front circum	20.49	1.82	27	17	22.67	2.07	29	19	++
Total circum	63.6	6.4	81	46	70.23	6.63	89.5	53	++

**Table 2:** The changes in the values of dental cast study of treatment group before and after the treatment.

The cephalometric values of the control group									
Variable	Before treatment (n = 34)				After treatment (n=34)				Sig.
	X	SD	Max	Min	X	SD	Max	Min	
SNA	80.5	3.45	88	74	80.69	3.36	87	73.5	-
SNB	76	3.36	85	70	76.1	3.38	85	70.5	-
ANB	4.78	1.47	8	1	4.62	1.65	9	1	-
N-S:Ar	126.35	3.94	135	118.5	126.8	4.39	138.5	118	-
S Ar Go	145.03	5.12	156.5	137	144.19	4.7	155	135	-
Ar Go Me	124.18	6.34	140	115	124.35	6.4	138	113	-
Bjork	395.56	5.65	409	386	395.37	6.65	409	386	-
N-S: Gn	69.38	3.83	76.5	61	69.41	3.94	76.5	61	-
N-S:Go Me	35.43	5.71	49	25	35.43	5.69	49	26	-
B	25.79	5.87	36	15.5	25.54	5.93	36	15	-
[Go Me]	70.18	5.37	82	61	70.37	5.38	82.5	61	-
[N Me]	117	7.1	135.5	99.5	117.59	7.33	138	100	-
[S Go]	74.59	5.55	88.5	66.5	75.04	5.55	90	67	-
Jarabak %	63.81	3.78	71.55	56.3	63.89	3.65	70.94	56.3	-
Id H	57.69	6.6	72	45	57.9	6.66	72	45	-
Id V	86.49	5.39	98	73	86.63	5.33	98	73	-
B H	53.49	6.59	68.5	40.5	53.69	6.76	68.5	40.5	-
B V	91.21	5.77	103	76	91.28	5.64	103	76	-
Pog H	50.68	7.85	69.5	37	50.78	7.74	69.5	37	-

Pog V	106.34	7.19	124	89	106.49	7.14	123	89	-
Gn H	48.31	7.99	68	34	48.5	7.9	68	34	-
Gn V	112.18	7.09	129.5	95	112.4	7.17	130	95	-
[B Co`]	91.85	5.49	105	82.5	91.94	5.4	105	82.5	-
[Gn Co`]	103.84	6.37	120	93	104.07	6.3	120	93	-
I: N-S	104.12	8.41	116	82	103.79	7.93	115.5	83	-
I: Spp	66.21	7.64	87	56	66.44	7.63	88	56	-
i: Go Me	93.44	6.29	109	77.5	93.63	6.15	106	79	-
I: i	127.13	10.08	164.5	114	126.81	9.21	161	115	-
6: Go Me	10.65	5.46	20	0	10.76	5.57	23	0	-
m H	34.19	5.84	50	24	34.63	5.82	50	24	-
m V	75.65	5.04	87	65	75.97	4.75	88	67	-
U Lip	-0.78	2.49	4	-8	-0.63	2.45	4	-8	-
L Lip	0.65	2.76	7	-6	0.56	2.59	7	-6	-
Sn H	78.72	5.14	88	68	78.81	5.31	89	68	-
Sn V	59.49	3.87	68	50	59.96	4.03	68	51	-
Ls H	79.68	5.86	89	67.5	80	6.03	90	67.5	-
Ls V	72.4	4.01	82	64	72.57	4.11	82	62.5	-
St H	71.68	6.37	83.5	59.5	72.37	6.51	85	59.5	-
St V	80.1	5.22	93.5	71	80.26	4.46	90.5	70	-
Li H	72.71	6.91	88	59	72.19	6.87	87.5	59	-
Li V	80.25	5.47	103	78.5	90.31	5.47	104	78	-
Sm H	63.43	7.04	80.5	50.5	63.68	7.07	80.5	50.5	-
Sm V	95.35	5.95	108	82.5	95.38	5.79	109	83	-
Pog` H	63.03	7.85	83	49.5	63.31	7.75	83	49.5	-
Pog` V	105.81	6.89	122	93	105.82	6.97	122	93	-

**Table 3:** The changes on the cephalometric values of control group before and after six months (equal to the period before and after the treatment with modified lip bumper).

The values of dental cast study of control group									
Variable	Before the treatment (n = 34)				After the treatment (n = 34)				Sig.
	X	SD	Max	Min	X	SD	Max	Min	
Over jet	4.79	2	9.5	1.5	4.69	1.87	8	1	-
Over bite	3.94	1.35	6	1.5	3.93	1.23	6.5	1.5	-
C - C	27.84	1.69	32	25	27.82	1.73	32	25	-
P - P	38.16	2.21	43	34	38.07	2.33	43	34	-
M - M	47.34	3.17	54	43	47.31	3.26	54	43	-
n P - P	39.2	2.93	45	34	39.2	2.93	45	34	
n M - M	48.97	3.66	56	42	48.97	3.66	56	42	
n P - e P	-0.68	3.81	7	-9	-1.66	3.3	7	-10	-
n M - e M	-1.81	5.02	10	-11.5	-1.92	5.08	10	-12	-
n LU	11.37	2.63	18	7	11.37	2.63	18	7	
n LL	9.37	2.63	16	5	9.37	2.63	16	5	
LL	8.21	2.71	15	3	7.97	2.61	13	3	-
n LL - e LL	-1.16	2.45	5	-6	-1.4	2.45	5	-6	-
Front circum	20.96	1.84	24	18	20.69	1.73	23	18	-
Total circum	64.41	6.01	78	49	63.24	5.94	78	49	-

**Table 4:** The changes in the dental cast study values of control group before and after 6 months.

The difference in cephalometric values of deep bite treatment group				
Variable	X	SD	Max	Min
SNA	0.23-	1.17	1.5	3-
SNB	0.45	1.11	2	2.5-
ANB	0.68-	0.98	1	3.5-
N-S Ar	0.32	1.64	4	2.5-
S Ar Go	0.02-	2.03	4	4-
Ar Go Me	0.41-	1.37	4	2.5-
Bjork	0.16	0.92	2	2-
N-S: Gn	0.5	1.12	3	1-
N-S: Go Me	0.36	1.1	3	1-
B	0.27	1.67	4	2.5-
[Go Me]	1.68	1.26	4	1-
[N Me]	4.05	2.24	9.5	0
[S Go]	2.68	0.97	5	1
Jarabak %	0.26	1.06	3.11	1.39-
Id H	2.39	1.22	4.5	0
Id V	3.41	2.14	7.5	0
B H	1.66	1.41	4	1.5-
B V	3.59	2.04	6.5	0.5-
Pog H	1.34	1.61	3.5	2.5-
Pog V	3.91	2.4	7.5	1-
Gn H	1.14	1.42	3.5	3-
Gn V	3.59	2.8	7	5-
[B Co`]	3.2	1.87	6.5	0.5
[Gn Co`]	3.5	2.09	6.5	0
I : N-S	3.93	7.66	32	3.5-
I : Spp	0.16-	8.79	32.5	16-
i : Go Me	0.48	3.52	10	5.5-
I : i	1.18-	11.38	28	39-
6 : Go Me	4.75	4.66	14	3.5-
m H	1.66	1.56	4.5	1-
m V	1.43	1.43	4.5	2-
U Lip	0.63-	1	1.5	2.5-
L Lip	0.22-	1.69	3.5	3.5-
Sn H	1.8	1.33	4	0
Sn V	1.52	1.31	4	1-
Ls H	2.14	1.41	5.5	0
Ls V	2.2	1.28	5	0
St H	2.21	2.22	7.5	0.5-
St V	2	1.05	4	0.5
Li H	2.2	2.08	7	2-
Li V	2.25	1.87	5	1-
Sm H	3.05	2.36	9	0
Sm V	3.34	2.22	8	0.5
Pog` H	2.2	1.49	5.5	0
Pog` V	2.8	3.15	8.5	3-

**Table 5:** The difference in the cephalometric values of deep bite treatment group before and after the treatment.

The difference in the values of dental cast study of deep bite treatment group				
Variable	X	SD	Max	Min
Over jet	1.09-	1.83	3	5-
Over bite	1.91-	0.96	0	3.5-
C - C	1.6	0.88	3	0
P - P	2.55	0.58	3.5	1.5
M - M	3.55	1.59	7	1
n P - P	0	0	0	0
n M - M	0	0	0	0
n LU	0	0	0	0
n LL	0	0	0	0
LL	2.36	1.22	5	1
Front circum	2.23	0.97	4	1
Total circum	6.73	1.78	10.5	4

**Table 6:** The difference in the values of dental cast study of deep bite treatment group.

The difference in the cephalometric values of normal bite treatment group				
Variable	X	SD	Max	Min
SNA	1	1.19	5	0.5-
SNB	1.09	0.72	2.5	0.5-
ANB	0.33-	0.73	1	2-
N-S Ar	0.11	1.82	3	4.5-
S Ar Go	1.11	2.92	8	5-
Ar Go Me	0.11	2.06	5	4-
Bjork	0.24	1.43	3	2.5-
N-S: Gn	0.02-	1.01	2	2-
N-S: Go Me	0.26	1.36	3.5	2-
B	0.09-	1.54	3	3-
[Go Me]	2.09	1.5	5	1-
[N Me]	3.2	2.19	8	0.5-
[S Go]	2.15	1.6	4.5	1-
Jarabak %	0.17	1.09	2.1	1.85-
Id H	2.96	2.62	9.5	1.5-
Id V	2.78	1.8	6.5	1-
B H	2.82	2.16	7.5	1-
B V	2.79	1.9	5.5	1.75-
Pog H	2.38	2.33	7.5	2-
Pog V	2.98	1.95	6.5	0.5-
Gn H	2.39	2.48	8.5	2-
Gn V	3.33	1.91	7.5	0

[B Co`]	2.85	2.47	7.5	1.5-
[Gn Co`]	2.72	2.28	7.5	2-
I : N-S	0.7	5.38	12.5	12-
I : Spp	0.89-	6.14	12	14-
i : Go Me	0.76	2.78	7	5-
I : i	1.15-	7.61	14	18-
6 : Go Me	4.2	3.94	10.5	5-
m H	2.09	1.6	5.5	1-
m V	1.37	2.01	5	1.5-
U Lip	0.51-	1.55	2.5	3.5-
L Lip	0.39	1.86	6	2.5-
Sn H	2.02	2.16	5.5	1.5-
Sn V	1.48	1.42	4	1-
Ls H	2.05	2.32	6	1.5-
Ls V	1.89	2.15	8	1.5-
St H	1.95	1.77	6	2.5-
St V	1.28	1.75	4.5	1-
Li H	3.3	2.81	8.5	1-
Li V	1.85	1.86	5.5	1.5-
Sm H	3.61	2.64	8	0.5-
Sm V	2.72	2.28	6.5	0.5-
Pog` H	2.7	2.43	8	1-
Pog` V	3.24	2.9	9	1.5-

**Table 7:** The difference in the cephalometric values of normal bite treatment group before and after the treatment.

The difference between the values of dental cast study of normal bite treatment group				
Variable	X	SD	Max	Min
Over Jet	1.87-	1.56	1	5-
Over Bite	1.46-	1.36	2.5	4-
C - C	2	1.01	4	1
P - P	2.53	0.77	4	1
M - M	3.48	1.76	8	1
n P - P	0	0	0	0
n M - M	0	0	0	0
n LU	0.09	0.42	2	0
n LL	0.09	0.42	2	0
LL	1.85	0.93	4	0
Front Circum	2.26	0.93	4	0
Total Circum	6.54	4.76	10	3

**Table 8:** The difference between the values of dental cast study of normal bite treatment group before and after the treatment.

The difference between the values of deep bite control group				
Variable	X	SD	Max	Min
SNA	-0.03	0.59	1	-1
SNB	0.03	0.95	1	-1
ANB	0.16-	0.47	0.5	-1
N-S Ar	0.28	1.39	3.5	-2
S Ar Go	0.06-	1.67	2.5	-3.5
Ar Go Me	0.5-	1.08	1	-3
Bjork	0.22-	0.86	2	-1.5
N-S: Gn	0.13-	0.59	0.5	-2
N-S: Go Me	0.09	1.02	3	-1
B	0.06-	0.93	1.5	-2.5
[Go Me]	0.88	1.07	4	0
[N Me]	0.56	0.63	2	0
[S Go]	0.38	0.83	1.5	-2
Jarabak %	0.29	0.69	1.65	-1.2
Id H	0.31	0.75	3	0
Id V	0.09	0.61	2	-1
B H	0.38	1.1	4	-0.5
B V	0.22	0.71	2	-1
Pog H	0.09	0.66	2	-1
Pog V	0.13	0.59	2	-1
Gn H	0.22	0.6	1.5	-1
Gn V	0.06	0.54	1	-1.5
[B Co`]	0.16	0.47	1	-0.5
[Gn Co`]	0.22	0.36	1	0
I: N-S	0.34	4.21	15	-4.5
I: Spp	0	4.24	6	-14.5
i: Go Me	0.09	1.7	3.5	3-
I: i	0.28-	5.31	7	-18
6: Go Me	0.38	1.54	3	-2.5
m H	0.38	0.24	2	-0.5
m V	0.5	0.89	2.5	-0.5
U Lip	0.06-	0.79	1	-2
L Lip	0.13	0.81	1.5	-1.5
Sn H	0.03	1.13	2	-3
Sn V	0.69	1.12	4	0
Ls H	0.31	0.95	2	-2
Ls V	0.38	1.09	4	-1
St H	0.39	0.3	2.5	0
St V	0.46	0.56	1.5	0

**Table 9:** The difference between the cephalometric values of deep bite control group before and after six months.

The difference between the values of dental cast study of deep bite control group				
Variable	X	SD	Max	Min
Over Jet	0.31-	1.55	3	-4.5
Over Bite	0	1	2	-2
C - C	0.19	0.54	2	0
P - P	0.06-	0.44	1	-1
M - M	0.06-	0.44	1	-1
n P - P	0	0	0	0
n M - M	0	0	0	0
n LU	0	0	0	0
n LL	0	0	0	0
LL	-0.31	0.68	0	-2.5
Front Circum	-0.25	0.58	0	-2
Total Circum	1.16-	1.56	0	-5

**Table 10:** The difference between the values of dental cast study of deep bite control group before and after six months.

The difference between the cephalometric values of normal bite control group				
Variable	X	SD	Max	Min
SNA	-0.14	0.54	1	-1
SNB	0.22	0.6	1	-1.5
ANB	0.14-	0.51	1	-1
N-S Ar	0.92	1.24	3.5	-1
S Ar Go	1.58-	2.02	2.5	-6
Ar Go Me	1	1.37	3	-2
Bjork	0	0.8	1.5	-1.5
N-S: Gn	0.11	0.61	1	-1
N-S: Go Me	0.06	0.68	1.5	-1
B	-0.03	1.47	2	-4
[Go Me]	-0.28	0.94	1.5	-2
[N Me]	0.78	0.83	2.5	-0.5
[S Go]	0.5	0.75	2	-1
Jarabak %	0.1	0.61	1.13	-1.1
Id H	0.08	0.75	2	-2
Id V	0.19	0.71	2	-1
B H	0.08	0.67	2	-1
B V	0.25	0.67	2	-1
Pog H	0.08	0.73	2.5	-1
Pog V	0.39	0.81	3	-1
Gn H	0.25	0.73	2.5	-1
Gn V	0.36	0.59	2	-0.5
[B Co`]	0.03	0.47	1	-1
[Gn Co`]	0.22	0.52	1	-1

I: N-S	-0.47	1.64	1	-4
I: Spp	0	1.64	4	-4
i: Go Me	0.28	1.22	3	-3
I: i	0.19	2.29	4.5	-5
6: Go Me	1.06	1.97	5.5	-2.5
m H	0.56	0.87	3	-0.5
m V	0.17	0.92	2	-1.5
U Lip	0.11	0.65	1.5	-1
L Lip	-0.01	0.52	1	-1
Sn H	0.14	0.64	1.5	-1
Sn V	0.28	0.75	3	0
Ls H	0.28	0.96	3.5	-0.5
Ls V	0.58	0.94	3	0
St H	0.18	0.77	2	-1
St V	-0.09	0.54	1	-1
Li H	0.33	0.91	2.5	-1
Li V	0.19	0.62	2	-0.5
Sm H	0.5	0.84	2	-1
Sm V	0.14	0.66	1.5	-1
Pog` H	0.22	0.75	2.5	-1
Pog` V	0.25	0.79	3	-0.5

**Table 11:** The difference between the cephalometric values of normal bite control group before and after six months.

The difference between the values of dental cast study of normal bite control group				
Variable	X	SD	Max	Min
Over jet	0.08	0.73	1.5	-1.5
Over bite	0.06	0.92	1.5	-2
C - C	-0.22	0.86	0.5	-3.5
P - P	-0.11	1.47	0	-2
M - M	0.06	0.38	1.5	-0.5
n P - P	0	0	0	0
n M - M	0	0	0	0
n LU	0	0	0	0
n LL	-0.06	0.24	0	-1
LL	-0.17	0.38	0	-1
Front circum	-0.28	0.57	0	-2
Total circum	-1.19	1.19	0	-4

**Table 12:** The difference between the values of dental cast study of normal bite control group before and after six months.

The amount of cephalometric changes in the deep bite sample									
Variable	Control group (n = 16)				Treatment group (n = 22)				Sig.
	X	SD	Max	Min	X	SD	Max	Min	
SNA	-0.03	0.59	1	-1	0.23-	1.17	1.5	3-	-
SNB	0.03	0.95	1	-1	0.45	1.11	2	2.5-	-
ANB	0.16-	0.47	0.5	-1	0.68-	0.98	1	3.5-	+
N-S Ar	0.28	1.39	3.5	-2	0.32	1.64	4	2.5-	-
S Ar Go	0.06-	1.67	2.5	-3.5	0.02-	2.03	4	4-	-
Ar Go Me	0.5-	1.08	1	-3	0.41-	1.37	4	2.5-	-
Bjork	0.22-	0.86	2	-1.5	0.16	0.92	2	2-	-
N-S: Gn	0.13-	0.59	0.5	-2	0.5	1.12	3	1-	+
N-S: Go Me	0.09	1.02	3	-1	0.36	1.1	3	1-	-
B	0.06-	0.93	1.5	-2.5	0.27	1.67	4	2.5-	-
[Go Me]	0.88	1.07	4	0	1.68	1.26	4	1-	+
[N Me]	0.56	0.63	2	0	4.05	2.24	9.5	0	++
[S Go]	0.38	0.83	1.5	-2	2.68	0.97	5	1	++
Jarabak %	0.29	0.69	1.65	-1.2	0.26	1.06	3.11	1.39-	-
Id H	0.31	0.75	3	0	2.39	1.22	4.5	0	++
Id V	0.09	0.61	2	-1	3.41	2.14	7.5	0	++
B H	0.38	1.1	4	-0.5	1.66	1.41	4	1.5-	++
B V	0.22	0.71	2	-1	3.59	2.04	6.5	0.5-	++
Pog H	0.09	0.66	2	-1	1.34	1.61	3.5	2.5-	++
Pog V	0.13	0.59	2	-1	3.91	2.4	7.5	1-	++
Gn H	0.22	0.6	1.5	-1	1.14	1.42	3.5	3-	++
Gn V	0.06	0.54	1	-1.5	3.59	2.8	7	5-	++
[B Co`]	0.16	0.47	1	-0.5	3.2	1.87	6.5	0.5	++
[Gn Co`]	0.22	0.36	1	0	3.5	2.09	6.5	0	++
I: N-S	0.34	4.21	15	-4.5	3.93	7.66	32	3.5-	-
I: Spp	0	4.24	6	-14.5	0.16-	8.79	32.5	16-	-
i: Go Me	0.09	1.7	3.5	3-	0.48	3.52	10	5.5-	-
I: i	0.28-	5.31	7	-18	1.18-	11.38	28	39-	-
6: Go Me	0.38	1.54	3	-2.5	4.75	4.66	14	3.5-	++
m H	0.38	0.24	2	-0.5	1.66	1.56	4.5	1-	++
m V	0.5	0.89	2.5	-0.5	1.43	1.43	4.5	2-	+
U Lip	0.06-	0.79	1	-2	0.63-	1	1.5	2.5-	-
L Lip	0.13	0.81	1.5	-1.5	0.22-	1.69	3.5	3.5-	-
Sn H	0.03	1.13	2	-3	1.8	1.33	4	0	++
Sn V	0.69	1.12	4	0	1.52	1.31	4	1-	+
Ls H	0.31	0.95	2	-2	2.14	1.41	5.5	0	++
Ls V	0.38	1.09	4	-1	2.2	1.28	5	0	++
St H	0.39	0.3	2.5	0	2.21	2.22	7.5	0.5-	++
St V	0.46	0.56	1.5	0	2	1.05	4	0.5	++
Li H	0.13	0.47	1	-1	2.2	2.08	7	2-	++
Li V	0.41	1.05	3	-1	2.25	1.87	5	1-	++
Sm H	0.34	0.91	2.5	-1	3.05	2.36	9	0	++
Sm V	0.03	1.02	2	-2	3.34	2.22	8	0.5	++
Pog` H	0.34	0.75	2	-1	2.2	1.49	5.5	0	++
Pog` V	0.25	0.66	2	-0.5	2.8	3.15	8.5	3-	++

**Table 13:** The difference between the cephalometric values of control and treatment groups from the deep bite group before and after the treatment.

The amount of change in the values of dental cast study of deep bite sample									
Variable	Control group (n = 16)				Treated group (n = 22)				Sig.
	X	SD	Max	Min	X	SD	Max	Min	
Over jet	0.31-	1.55	3	-4.5	1.09-	1.83	3	5-	-
Over bite	0	1	2	-2	1.91-	0.96	0	3.5-	++
C - C	0.19	0.54	2	0	1.6	0.88	3	0	++
P - P	0.06-	0.44	1	-1	2.55	0.58	3.5	1.5	++
M - M	0.06-	0.44	1	-1	3.55	1.59	7	1	++
n P - P	0	0	0	0	0	0	0	0	
n M - M	0	0	0	0	0	0	0	0	
n LU	0	0	0	0	0	0	0	0	
n LL	0	0	0	0	0	0	0	0	
LL	-0.31	0.68	0	-2.5	2.36	1.22	5	1	++
Front circum	-0.25	0.58	0	-2	2.23	0.97	4	1	++
Total circum	1.16-	1.56	0	-5	6.73	1.78	10.5	4	++

**Table 14:** The difference between the values of dental cast study of control and treated group from the deep bite sample before and after the treatment.

The Amount of Cephalometric Changes in The Deep Bite Sample									
Variable	Control group (n = 18)				Treated group (n = 23)				Sig.
	X	SD	Max	Min	X	SD	Max	Min	
SNA	-0.14	0.54	1	-1	1	1.19	5	0.5-	++
SNB	0.22	0.6	1	-1.5	1.09	0.72	2.5	0.5-	++
ANB	0.14-	0.51	1	-1	0.33-	0.73	1	2-	-
N-S Ar	0.92	1.24	3.5	-1	0.11	1.82	3	4.5-	-
S Ar Go	1.58-	2.02	2.5	-6	1.11	2.92	8	5-	++
Ar Go Me	1	1.37	3	-2	0.11	2.06	5	4-	-
Bjork	0	0.8	1.5	-1.5	0.24	1.43	3	2.5-	-
N-S: Gn	0.11	0.61	1	-1	0.02-	1.01	2	2-	-
N-S: Go Me	0.06	0.68	1.5	-1	0.26	1.36	3.5	2-	-
B	-0.03	1.47	2	-4	0.09-	1.54	3	3-	-
[Go Me]	-0.28	0.94	1.5	-2	2.09	1.5	5	1-	++
[N Me]	0.78	0.83	2.5	-0.5	3.2	2.19	8	0.5-	++
[S Go]	0.5	0.75	2	-1	2.15	1.6	4.5	1-	++
Jarabak %	0.1	0.61	1.13	-1.1	0.17	1.09	2.1	1.85-	-
Id H	0.08	0.75	2	-2	2.96	2.62	9.5	1.5-	++
Id V	0.19	0.71	2	-1	2.78	1.8	6.5	1-	++
B H	0.08	0.67	2	-1	2.82	2.16	7.5	1-	++
B V	0.25	0.67	2	-1	2.79	1.9	5.5	1.75-	++
Pog H	0.08	0.73	2.5	-1	2.38	2.33	7.5	2-	++
Pog V	0.39	0.81	3	-1	2.98	1.95	6.5	0.5-	++
Gn H	0.25	0.73	2.5	-1	2.39	2.48	8.5	2-	++
Gn V	0.36	0.59	2	-0.5	3.33	1.91	7.5	0	++
[B Co`]	0.03	0.47	1	-1	2.85	2.47	7.5	1.5-	++
[Gn Co`]	0.22	0.52	1	-1	2.72	2.28	7.5	2-	++

I: N-S	-0.47	1.64	1	-4	0.7	5.38	12.5	12-	-
I: Spp	0	1.64	4	-4	0.89-	6.14	12	14-	-
i: Go Me	0.28	1.22	3	-3	0.76	2.78	7	5-	-
I: i	0.19	2.29	4.5	-5	1.15-	7.61	14	18-	-
6: Go Me	1.06	1.97	5.5	-2.5	4.2	3.94	10.5	5-	++
m H	0.56	0.87	3	-0.5	2.09	1.6	5.5	1-	++
m V	0.17	0.92	2	-1.5	1.37	2.01	5	1.5-	++
U Lip	0.11	0.65	1.5	-1	0.51-	1.55	2.5	3.5-	-
L Lip	-0.01	0.52	1	-1	0.39	1.86	6	2.5-	-
Sn H	0.14	0.64	1.5	-1	2.02	2.16	5.5	1.5-	++
Sn V	0.28	0.75	3	0	1.48	1.42	4	1-	++
Ls H	0.28	0.96	3.5	-0.5	2.05	2.32	6	1.5-	++
Ls V	0.58	0.94	3	0	1.89	2.15	8	1.5-	++
St H	0.18	0.77	2	-1	1.95	1.77	6	2.5-	++
St V	-0.09	0.54	1	-1	1.28	1.75	4.5	1-	++
Li H	0.33	0.91	2.5	-1	3.3	2.81	8.5	1-	++
Li V	0.19	0.62	2	-0.5	1.85	1.86	5.5	1.5-	++
Sm H	0.5	0.84	2	-1	3.61	2.64	8	0.5-	++
Sm V	0.14	0.66	1.5	-1	2.72	2.28	6.5	0.5-	++
Pog` H	0.22	0.75	2.5	-1	2.7	2.43	8	1-	++
Pog` V	0.25	0.79	3	-0.5	3.24	2.9	9	1.5-	++

**Table 15:** The difference between the cephalometric values of control and treated groups from normal bite sample before and after the treatment.

The Amount of Changes in the Dental Cast Study of Normal Bite Sample									
Variable	Control group (n = 18)				Treated group (n = 23)				Sig.
	X	SD	Max	Min	X	SD	Max	Min	
Over jet	0.08	0.73	1.5	-1.5	1.87-	1.56	1	5-	++
Over bite	0.06	0.92	1.5	-2	1.46-	1.36	2.5	4-	++
C - C	-0.22	0.86	0.5	-3.5	2	1.01	4	1	++
P - P	-0.11	1.47	0	-2	2.53	0.77	4	1	++
n P - P	0	0	0	0	0	0	0	0	
n M - M	0	0	0	0	0	0	0	0	
n LU	0	0	0	0	0.09	0.42	2	0	
n LL	-0.06	0.24	0	-1	0.09	0.42	2	0	
LL	-0.17	0.38	0	-1	1.85	0.93	4	0	++
Front circum	-0.28	0.57	0	-2	2.26	0.93	4	0	++
Total circum	-1.19	1.19	0	-4	6.54	4.76	10	3	++

**Table 16:** The difference between the values of dental cast study of control and treated groups from normal bite sample before and after the treatment.

The Amount of Cephalometric Changes in the Treated Sample									
Variable	Deep bite (n = 22)				Normal bite (n = 23)				Sig.
	X	SD	Max	Min	X	SD	Max	Min	
SNA	-0.23	1.17	1.5	3-	1	1.19	5	-0.5	++
SNB	0.45	1.11	2	2.5-	1.09	0.72	2.5	-0.5	+
ANB	-0.68	0.98	1	3.5-	-0.33	0.73	1	-2	-
N-S Ar	0.32	1.64	4	2.5-	0.11	1.82	3	-4.5	-
S Ar Go	-0.02	2.03	4	-4	1.11	2.92	8	-5	-
Ar Go Me	-0.41	1.37	4	-2.5	0.11	2.06	5	-4	-
Bjork	0.16	0.92	2	-2	0.24	1.43	3	-2.5	-
N-S: Gn	0.5	1.12	3	1-	-0.02	1.01	2	-2	-
N-S: Go Me	0.36	1.1	3	1-	0.26	1.36	3.5	-2	-
B	0.27	1.67	4	2.5-	-0.09	1.54	3	-3	-
[Go Me]	1.68	1.26	4	1-	2.09	1.5	5	-1	-
[N Me]	4.05	2.24	9.5	0	3.2	2.19	8	-0.5	-
[S Go]	2.68	0.97	5	1	2.15	1.6	4.5	-1	-
Jarabak %	0.26	1.06	3.11	1.39-	0.17	1.09	2.1	-1.85	-
Id H	2.39	1.22	4.5	0	2.96	2.62	9.5	-1.5	-
Id V	3.41	2.14	7.5	0	2.78	1.8	6.5	-1	-
B H	1.66	1.41	4	1.5-	2.82	2.13	7.5	-1	+
B V	3.59	2.04	6.5	0.5-	2.79	1.9	5.5	-1.75	-
Pog H	1.34	1.61	3.5	2.5-	2.38	2.33	7.5	-2	-
Pog V	3.91	2.4	7.5	1-	2.98	1.95	6.5	-0.5	-
Gn H	1.14	1.42	3.5	3-	2.39	2.48	8.5	-2	+
Gn V	3.59	2.8	7	5-	3.33	1.91	7.5	0	-
[B Co`]	3.2	1.87	6.5	0.5	2.85	2.47	7.5	-1.5	-
[Gn Co`]	3.5	2.09	6.5	0	2.72	2.28	7.5	-2	-
I: N-S	3.93	7.66	32	-3.5	0.7	5.38	12.5	-12	-
I: Spp	0.16-	8.79	32.5	-16	-0.89	6.14	12	-14	-
i: Go Me	0.48	3.52	10	5.5-	0.76	2.78	7	-5	-
I: i	-1.18	11.38	28	-39	-1.15	7.61	14	-18	-
6: Go Me	4.75	4.66	14	3.5-	4.2	3.94	10.5	-5	-
m H	1.66	1.56	4.5	1-	2.09	1.6	5.5	-1	-
m V	1.43	1.43	4.5	2-	1.37	2.01	5	-1.5	-
U Lip	-0.63	1	1.5	2.5-	-0.51	1.55	2.5	-3.5	-
L Lip	-0.22	1.69	3.5	3.5-	0.39	1.86	6	-2.5	-
Sn H	1.8	1.33	4	0	2.02	2.16	5.5	-1.5	-
Sn V	1.52	1.31	4	1-	1.48	1.42	4	-1	-
Ls H	2.14	1.41	5.5	0	2.05	2.32	6	-1.5	-
Ls V	2.2	1.28	5	0	1.89	2.15	8	-1.5	-
St H	2.21	2.22	7.5	0.5-	1.95	1.77	6	-2.5	-
St V	2	1.05	4	0.5	1.28	1.75	4.5	-1	-
Li H	2.2	2.08	7	2-	3.3	2.81	8.5	-1	-
Li V	2.25	1.87	5	1-	1.85	1.86	5.5	-1.5	-
Sm H	3.05	2.36	9	0	3.61	2.64	8	-0.5	-
Sm V	3.34	2.22	8	0.5	2.72	2.28	6.5	-0.5	-
Pog` H	2.2	1.49	5.5	0	2.7	2.43	8	-1	-
Pog` V	2.8	3.15	8.5	3-	3.24	2.9	9	-1.5	-

**Table 17:** The difference between the cephalometric values of deep bite and normal bite groups from treated sample before and after the treatment.

The amount of changes in the values of dental cast study in the treated sample									
Variable	Deep bite (n = 22)				Normal bite (n = 23)				Sig.
	X	SD	Max	Min	X	SD	Max	Min	
Over jet	1.09	1.83	3	-5	-1.87	1.56	1	-5	-
Over bite	-1.91	0.96	0	3.5	-1.46	1.39	2.5	-4	-
C - C	1.6	0.88	3	0	2	1.01	4	1	-
P - P	2.55	0.58	3.5	1.5	2.53	0.77	4	1	-
M - M	3.55	1.59	7	1	3.48	1.76	8	1	-
n P - P	0	0	0	0	0	0	0	0	
n M - M	0	0	0	0	0	0	0	0	
n LU	0	0	0	0	0	0	0	0	
n LL	0	0	0	0	0	0	0	0	
LL	2.36	1.22	5	1	1.85	0.93	4	0	-
Front circum	2.23	0.97	4	1	2.26	0.84	4.5	1	-
Total circum	6.73	1.78	10.5	4	6.54	1.76	10	3	-

**Table 18:** The difference in the results of dental cast study of deep bite and normal bite from treated sample before and after the treatment.

## Discussion

There was an improvement in the sagittal relationship between upper and lower jaws in the treatment group where ANB angle decreased by  $0.5^\circ$  due to the anterior movement of point B as the result from modified lip bumper which stimulates bone growth in the anterior area of mandible and causing labial bodily movement of the lower incisors. This dental movement was more clear in the normal bite treatment group when it compared with deep bite treatment group where the horizontal coordinate of point B increased by 2.82 mm in normal bite treatment group while it increased 1.66 mm in deep bite treatment group, this due to intense musculature pattern of deep bite group which causing more resistance to point B movement by lower lip muscles comparing with normal bite group.

There was an improvement in the vertical relationship between upper and lower jaws in the treatment group when it compared with control group. This improvement was more clear in deep bite treatment group when it compared with control group as the result of distalization and uprighting the lower first molar as the effect of modified lip bumper.

There was an increasing in the length of mandible in the treatment group when it compared with control group, this result coincided with Vanarsdall studies. This increasing in mandible length was more clear in normal bite group, where the distance [Go Me] increased by 2.08 mm, than deep bite, where [Go Me] increased by 1.68 mm. This increasing in the mandible length results from

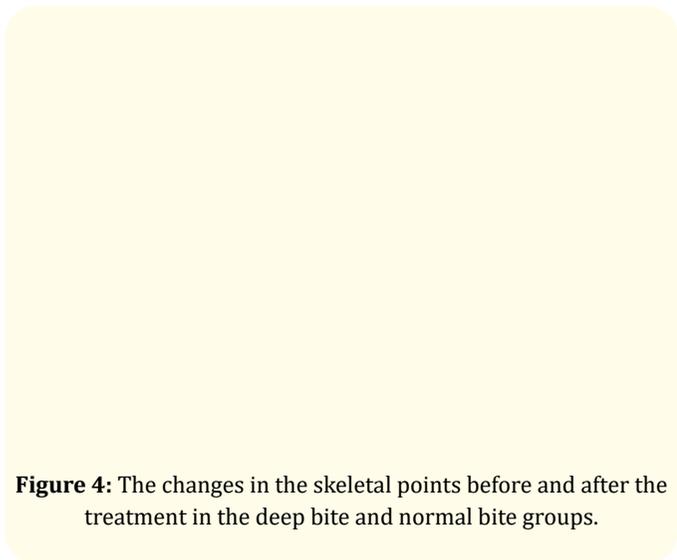
bone formation in the anterior area of mandible as the effect of modified lip bumper. The placing of modified lip bumper pads in the depth of vestibular transmits the muscles forces to periosteum causing periosteal pull which stimulates bone growth.

There was a significant increasing in the anterior face height [N Me] by 3.61 mm of treatment group, where it increases by 4.05 mm in deep bite treatment group and 3.02 mm in normal bite treatment group. This increasing in height is due to open bite by uprighting first molar as the effect of modified lip bumper and because of bone formation at point Me causing by periosteal pull resulting from lower lip muscle forces, so we agreed with Perillo study and his friends.

There was a significant increase in posterior height face of treatment group by 2.41 mm, where it increased by 2.68 mm in deep bite treatment group and 2.15 mm in normal bite treatment group. This happened because the effect of modified lip bumper on uprighting the lower first molars which causes decrease in overbite (bite open).

The lateral cephalometric study was done for the coordinates of points Id, B, Pog, and Gn via axial coordinates N-Se and the perpendicular on N-Se at point Se before and after the treatment in the treatment group and compared them with control group. The study was shown increased of horizontal coordinates of these points by 2.39 mm, 1.66 mm, 1.34 mm, 1.14 mm respectively in the deep bite treatment group, while they increased in the normal bite treatment group by 2.96 mm, 2.82 mm, 2.38 mm and 2.39

mm respectively. These increases were significant in treatment group comparing with control group, as the result of modified lip bumper where the labial pads placing in front of lower anterior area by (1 - 2) mm and based lower on the depth of the vestibular groove and as the result of transmitted muscle forces from labial and mentalis muscles causing periosteal pull which stimulated the bone formation at this area. This increase was more clear in the vertical coordinates because the bite opened as the result of distalization and uprighting of lower first molars (Figure 4).

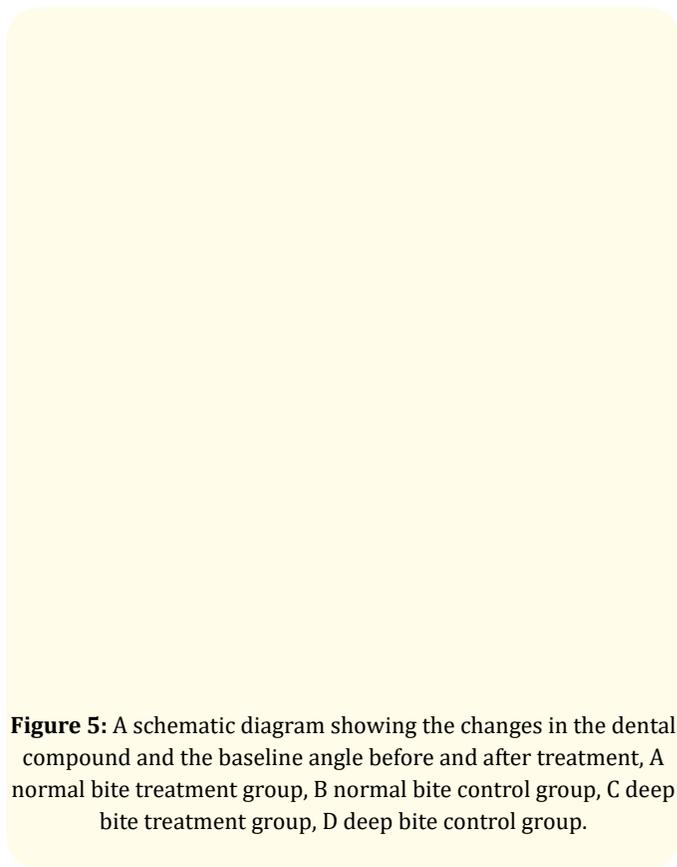


**Figure 4:** The changes in the skeletal points before and after the treatment in the deep bite and normal bite groups.

The study showed a significant increase in the length of mandible of the treatment group when it compared with control group, where the distance [B-Co'] increased by 3.02 mm (3.2 mm in the deep bite treatment group, and 2.85 mm in the normal bite treatment group), and the distance [Gn-Co'] increased by 3.1mm (3.5 mm in deep bite treatment group and 2.73 mm in the normal bite treatment group). This increase is due to anterior movement of points B and Gn as the result of bone formation causing by the effect of modified lip bumper, and because of anterior bodily movement of lower incisors which moved point B anteriorly.

For study the effect of modified lip bumper on the mandibular first molars, it was considered two variables which are the angel of the occlusal plane of first molar with the mandibular base and the coordinates of point m. The study showed an increase in the mentioned angel by 4.75° in the deep bite treatment group and 4.2° in the normal bite treatment group, this increase was valuable when it compared with control group. It was also an increase in the horizontal coordinate of point m by 1.66 mm and 2.09 mm in the deep bite treatment and normal bite treatment groups respectively,

while the vertical coordinate of point m increased by 1.43 mm and 1.37 mm respectively. This can be explained as the result of transmitted forces which generated by orbicularis oris and mentalis muscles from labial pads of lip bumper then via orthodontic wires to the vestibular tube of orthodontic bands pushed the lower first molars crowns distally and the roots mesially, this what was referred by Nevant study, so the uprighting and distalization movement happened to the mandibular first molars, so we agreed with Ghafari [14], Ten Hoeve, Cetlin , Davidovitch, Germec, Taner [13] and O'Donnell studies (Figure 5).



**Figure 5:** A schematic diagram showing the changes in the dental compound and the baseline angle before and after treatment, A normal bite treatment group, B normal bite control group, C deep bite treatment group, D deep bite control group.

The effect of Lip Bumper treatment on the soft tissue profile was studied based on the lip relationship with the Ricketts aesthetic line and the coordinates of points Sn, Ls, St, Li, Sm and Pog` for axial coordinates which depend in our study.

For the relationship of the lips with the aesthetic Ricketts line, the changes we obtained were not considered qualitative when compared with the control sample and when comparing values before and after treatment. The upper lip was reduced by its relation with the Ricketts line by 0.63 mm at the treated deep

bite group and 0.51 mm at the treated normal bite group. This corresponds to the adjustment of the upper incisors axes that were obtained during the treatment.

The horizontal coordinates of Sn, Ls, St, Li, Sm and Pog` points increased by 1.8 mm, 2.14 mm, 2.21 mm, 2.2 mm, 3.05 mm and 2.2 mm, respectively in the treated deep bite group, 2.02 mm, 2.05 mm, 1.95 mm, 3.3 mm, 3.61 mm, and 2.7 mm respectively in the treated normal bite group. The difference was qualitative compared with the control sample, and these changes were more pronounced at the horizontal coordinates of point Sm compared to the value before treatment 61.7 mm and later 65.08 mm.

The vertical coordinates of Sn, Ls, St, Li, Sm, and Pog points increased by 1.52 mm, 2.2 mm, 2 mm, 2.25 mm, 3.34 mm and 2.8 mm, respectively, at the treated deep bite group, 1.48 mm, 1.89 mm, 1.28 mm, 1.85 mm, 2.72 mm, and 3.24 mm, respectively, in the treated normal bite group. This difference was qualitative when comparing these changes with the control sample, and these changes were more pronounced at the vertical coordinates of Sm and Pog when comparing their values before and after treatment.

The position of the points of Sn, Ls, St, Li is related to the upper incisors and lip position. Modified lip bumper treatment improved labial efficiency, and this was reflected in the placement of these points, in addition to use of utility forces in other cases.

The position of the points Sm and Pog` is related to the skeletal bone which the soft tissue is based on it, so the bone formation which resulting from the effect of Lip Bumper in the front region of the lower jaw caused the increase in coordinates of these points, which means the improvement of face profile and decrease the clarity of the oral fold of the mental, as indicated by the study of Ten Hove, Cetlin (Figure 6).

**Figure 6:** Shows the changes in soft tissue points before and after the treatment for the treated sample (normal bite group, deep bite group).

The results obtained during the study of all dental casts showed a significant difference when comparing the results obtained after treatment with the results of the study prior to treatment, as well as when comparing the results of the study of the treatment sample with the control sample. This suggests that Lip Bumper therapy plays an important role in increasing the dimensions of the lower dental arch in both sagittal and transverse directions, as well as in increasing the circumference and length of the lower dental arch. We agree with most studies that studied the effect of Lip Bumper on the dimensions of the lower dental arch Ghafari [14], Hoeve, Cetlin, Ten Hove, Davidovitch, Ingervall, Grossen, Ingervall, Hasler, Nidoli, O'Donnell, Werner.

The increase in the dimensions of the lower dental arch in the transvers direction due to exclusion the lateral arms of the lip bumper the effect of the compressive cheek muscles on the lower dental arch and allows the lingual muscles alone to contribute to increasing the dimensions of the lower arch in the opposing direction, resulting in a buccal bodily movement of the posterior teeth.

The results of the study showed a significant increase in the length of the lower dental arch in the sample treated with Lip Bumper by 2.36 mm at the deep bite group and 1.85 mm at the normal bite group. The increase in the length of the lower dental arch is due to the anterior movement of the lower incisors, the distalization and uprighting of the lower first molars, and the increase in the circumference of the lower dental arch because of Modified Lip Bumper. We agreed with the studies of Davidovitch, Ingervall, Hasler, and Osborn.

The effectiveness of modified lip bumper was also tested to reduce the crowding of the lower dental arch and thus reduce the need for the extraction by measuring the size of the basal bone in the anterior region of the lower dental arch between the mesial surfaces of canines and measuring the total bone size between the mesial surfaces of lower first molar. A significant increase in baseline bone size in the front region by 2.23 mm at the treated deep bite group and 2.26 mm in the treated normal bite group, which is attributed to the anterior movement of the lower incisors and the increase of the lower dental arch` width in the canine area. The study also showed a significant increase in total basal bone size by 6.73 mm in the treated deep bite group and 6.54 mm in the treated normal bite group. We agree with the Davidovitch study. This increase is due to an increase in the circumference of the lower dental arch due to the exclusion of the effect of the cheeks muscles Lips, uprighting and distalization of the lower first molars, and the labial bodily movement of the lower incisors, and agree with the studies of Davidovitch, Nidoli, Werner.

## Conclusions

The main goal of the current study is to identify the most important skeletal and alveolar dental changes that can result from the application of modified lip bumper in the mandible during the orthodontic treatment of class II malocclusion cases which are caused by retrusion of mandible. The research was depended on dental casts study and lateral cephalometric analysis of patients before and after the placing of modified Lip Bumper. The results show:

1. The modified Lip Bumper contributes to the realization of osteotomy under the periosteum on the front edge of the mandible.
2. Modified Lip Bumper contributes to improving the face profile, especially the "lip profile".
3. Modified Lip Bumper contributes to a slight improvement of the jaw relationship in sagittal plane.
4. Treatment with modified Lip Bumper improves the placement of the lower incisors and their relationship with the upper incisors as to the bodily movement of the lower incisors if they are used properly.
5. The modified Lip Bumper contributes to achieve the distal movement and uprighting of mandibular first molars.
6. The modified Lip Bumper treatment causes a significant increase in the circumference of the lower dental arch resulting from increasing the dimensions of the lower arch in both sagittal and transverse directions.
7. Treatment with modified Lip Bumper leads to the elimination of crowding in the anterior area of lower dental arch by causing bodily movement of the lower incisors and increasing the width of the lower dental arch.
8. Modified Lip Bumper helps to improve oral muscular effectiveness.

## Recommendations

1. Utilization of modified Lip Bumper in the treatment of crowding in some cases, especially those related to functional disorders.
2. Utilization of modified Lip Bumper to improve muscular effectiveness.
3. The use of modified Lip Bumper rather than those available in the market when indicated for use in the context of orthodontic treatment because they have a role in the control of oral effectiveness and movement of the teeth, especially when the uprighting of molar is indicated.
4. Do more valuable studies to test the effect of modified Lip Bumper on muscular effectiveness, jaw relationship and the use of CT technique in this field.

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