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ORIGINAL ARTICLE

# Evaluation of Skeletal and Dental Effects of Modified Jasper Jumper Appliance and Delaire Face Mask with Pancherz Analysis

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## ABSTRACT

**Objective:** The aim of this study was to evaluate the skeletal and dental changes in Class III patients treated with Modified Jasper Jumper appliance and Delaire face mask before the growth peak.

**Methods:** A study sample comprising 16 patients with functional Class III malocclusion treated with Modified Jasper Jumper appliance and 17 patients treated with Delaire face mask was compared with a control group comprising 13 patients. Pancherz analysis was used as the analysis method.

**Results:** In both treatment groups forward movement of maxillary base and incisors and an increase in the overjet while no positional change in the mandibular base was observed. In the Modified Jasper Jumper group, 4.63 mm overjet correction was due to 51.4% skeletal and 48.6% dental changes; 4.77 mm Class III molar correction was due to 49.9% skeletal and 50.1% dental changes. In the Delaire face mask group, 5.17 mm overjet correction was due to 70.6% skeletal and 29.4% dental changes and 4.87 mm Class III molar correction was due to 75% skeletal and 25% dental changes.

**Conclusion:** It was shown that both appliances were skeletally and dentally effective. Therefore, Modified Jasper Jumper therapy may be an alternative treatment modality for patients with poor cooperation, who are not ideal recipients for Delaire face mask.

**Keywords:** Jasper jumper appliance, Delaire face mask, Pancherz analysis, Class III treatment malocclusion

## INTRODUCTION

In Class III malocclusions with skeletal components, there are two treatment approaches: early orthopedic/orthodontic treatment and orthognathic surgery after the growth period. The main goal of choosing the treatment method is to choose a treatment modality most suitable for the patient (1).

Patient cooperation is inevitable for appliances used in early orthopedic treatment of Class III malocclusions such as face mask, chin cup, and functional appliances. Use of these appliances can be uncomfortable, and the treatment time can be long; thus, the cooperation from many of these patients may be poor, negatively influencing the treatment effects (2). Laxity in cooperation of wearing these appliances may lead to not only a compromised result but also slow treatment progress, "wasted" clinic time, and frustration.

In Class II anomalies, fixed functional appliance therapies using Jasper Jumper or Herbst appliance are quite common, whereas in Class III anomalies, such fixed appliance therapies are rare. Treatment options of Class III malocclusions that can be undertaken irrespective of patient cooperation have interested researchers; however, these have only consisted of few case presentations and studies (4-6).

The aim of this study was to evaluate the dentoalveolar and skeletal effects of the Modified Jasper Jumper appliance and Delaire face mask, both of are used in early treatment of Class III malocclusions.

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## METHODS

The protocol of this project (Number: 2007/2936) was reviewed by the Ethics Committee. Each subject's parent/guardian signed an informed consent form prior to treatment initiation.

Forty-six patients aged between 8 and 11 years with functional Class III malocclusions who were referred to our clinic were included in the study; of these, 17 patients were treated using Delaire face mask and 16 patients using Modified Jasper Jumper appliance. The control group comprised 13 patients with the same features and in the same age range. All patients were assigned to groups depending on their order of arrival at the clinic.

Patient selection was done based on the following criteria:

1. Skeletal relationship: Skeletal Class III malocclusion with maxillary retrognathism (SNA<79°), ANB angle less than −1°, and a horizontal growth pattern (S-N/Go-Me: 30–32°).
2. Dental relationship: Angle Class III malocclusion with an anterior crossbite. The patients could achieve an edge-to-edge incisor position.

No subjects had a history of any other craniofacial anomalies, and none had undergone prior orthodontic treatment.

The gender distribution and chronological and skeletal mean ages at treatment initiation are shown in Table 1. Hand-wrist radiographs were taken for determining growth potential and bone age prior to treatment initiation, and these were calculated using Greulich and Pyle atlas (7).

Treatment procedures and periodic follow-ups were conducted by the same orthodontist for each subject. All treatments were discontinued once Class I molar relationship and 2-3 mm overjet were obtained. As the patients were in the mixed dentition period, other treatment mechanics were not used. Clinical investigations were performed 1 day after appliance removal.

### Modified Jasper Jumper Appliance

The difference of modified use of Jasper Jumper from its classical application is that the modular system of the modified appliance is fixed between upper canine and lower molar, instead of upper molar and lower canine, to correct the Class III relationship. Because the patients were in mixed dentition, Modified Jasper Jumper appliance was applied on the rigid intraoral anchorage unit (Figure 1).

When the Modified Jasper Jumper appliance used in our study had been activated at 4 mm overjet in rest position, a 250 g force was delivered. The appliance was active till 2–3 mm overjet was achieved. In all the patients, Modified Jasper Jumper appliance was removed when adequate overjet and Class I molar relationship were achieved (Figure 2a-c).

### Delaire Face Mask

The Delaire face mask (Figure 3a, b) used in our study applied force at a 25–30° angle to the occlusal plane in a downward direction. The magnitude of the force was 500 g per side, total 1000 g. The duration of the force was 16 h/day. Because of the patients being in mixed dentition, the face mask was applied on the rigid intraoral anchorage unit (Figure 3c). All patients were examined once a month and treatment was continued till 2-3 mm overjet was achieved.

### Pancherz Analysis

For cephalometric evaluation, Pancherz analysis, introduced in 1979 and later used for evaluating skeletal and dentoalveolar



**Table 1.** Statistics related to age, sex, and observation periods

| | | Modified Jasper Jumper (n=16) | Face Mask (n=17) | Control (n=13) | p |
|---|---|---|---|---|---|
| Chronological age (year) | | 9.67±0.95 | 9.55± 0.97 | 9.14±0.40 | 0.209 |
| Skeletal age (year) | | 9.63±1.09 | 9.88±1.04 | 9.36±0.88 | 0.332 |
| Observation period (month) | | 4.90 ±0.37 | 6.41±0.50 | 6.00±0.00 | p<0.001** |
| Sex | Female | 8 | 7 | 8 | 0.543 |
| | Male | 8 | 10 | 5 | |

*p<0.05, **p<0.001

**Figure 1.** Application of modified jasper jumper appliance


**Figure 2 a-c.** Pretreatment intraoral photograph of a patient in Modified Jasper Jumper treatment group (a); Intraoral photograph of a patient during treatment in Modified Jasper Jumper treatment group (b); Post-treatment intraoral photograph of a patient in Modified Jasper Jumper treatment group (c)

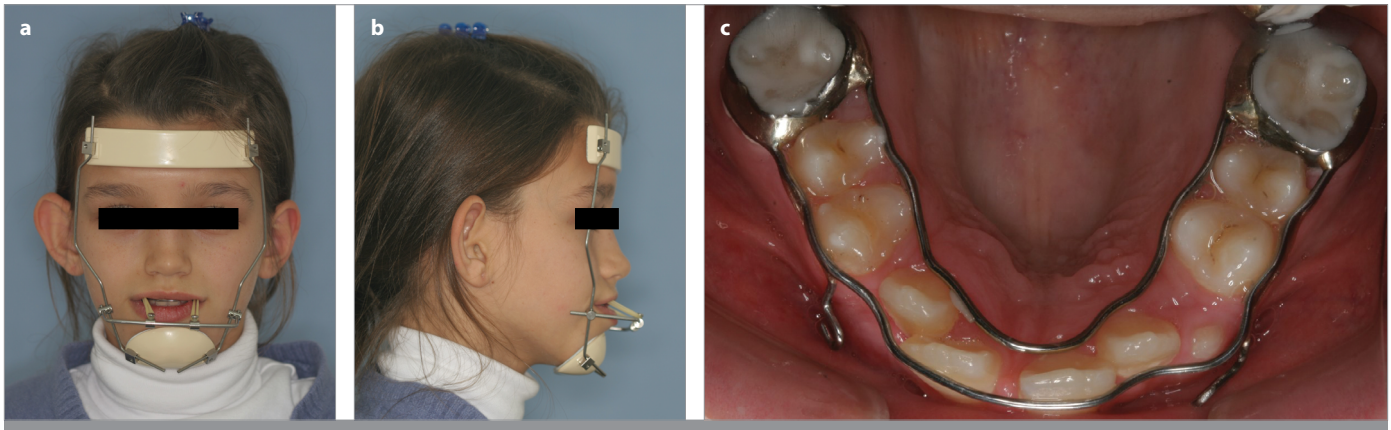


**Figure 3 a-c.** Application of Delaire face mask (frontal view) (a), Application of Delaire face mask (lateral view) (b); Intraoral anchorage unit (c)

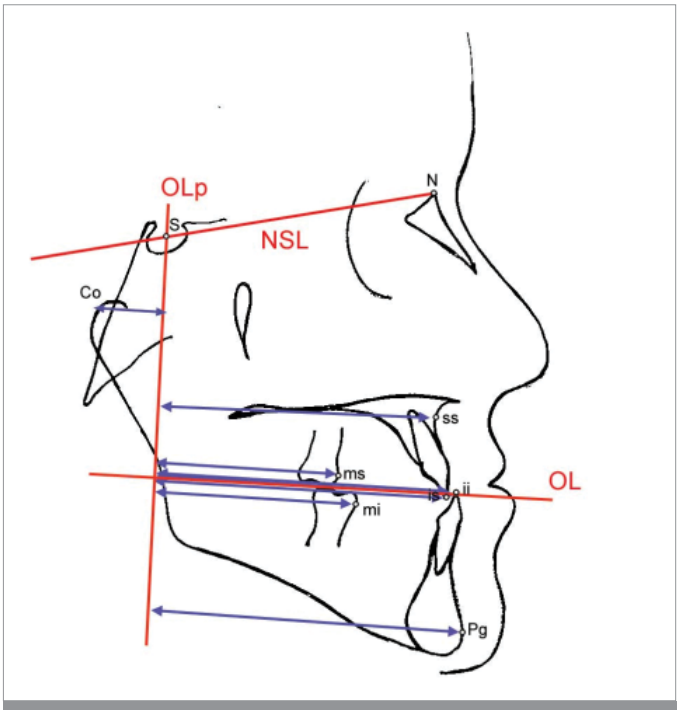


**Figure 4.** Measuring points and reference lines used in Pancherz analysis: 1, condylion (Co); 2, upper incisor(is); 3, lower incisor(ii); 4, upper molar (ms); 5, lower molar (mi); 6, pogonion (Pg); 7, subspinal point(ss); reference points: 8, sella (S), 9, nasion (N); and reference lines: 10, nasion-sella line (NSL), 11, occlusal line (OL), and 12, occlusal line perpendicular (OLp)

effects of functional appliances, was used (8-10). Points and reference lines used in Pancherz analysis are shown in Figure 4.

For all the linear measurements, OL, OLp, and NSL from the first head film were used as a reference grid9. The grid was transferred from the first tracing to the second tracing by superimposition of the radiographs on NSL with S as the registering point. Measurements were made on OLp, parallel to OL.

Skeletal measurements:
1. ss/OLp: Position of the maxillary base
2. Pg/OLp: Position of the mandibular base
3. Co/OLp: Position of condyle head
4. Pg/OLp + Co/OLp: Length of the mandibular jaw

Combined skeletal and dental measurements:
1. is/OLp: Position of the maxillary central incisor
2. ii/OLp: Position of the mandibular central incisor
3. ms/OLp: Position of the maxillary permanent first molar
4. mi/OLp: Position of the mandibular permanent first molar
5. is/OLp–ii/OLp: Overjet
6. ms/OLp–mi/OL: Molar relation (a positive value indicates a distal relation; a negative value indicates a normal relation)

Measurements evaluating dental changes within maxilla and mandible:
1. is/OLp (d)–ss/OLp (d): Change in position of the maxillary central incisor within the maxilla
2. ii/OLp (d)–Pg/OLp (d): Change in position of the mandibular central incisor within the mandible
3. ms/OLp (d)–ss/OLp (d): Change in position of the maxillary permanent first molar within the maxilla
4. mi/OLp (d)–Pg/OLp (d): Change in position of the mandibular permanent first molar within the mandible

While evaluating the overjet and molar relation changes, parameters 1 and 2 were used for skeletal contribution and parameters 11–14 were used for dental contribution.

### Statistical Analysis

The Number Cruncher Statistical System (NCSS) 2007 and Power Analysis and Sample Size Software (PASS) 2008 Statistical Software packages (NCSS; Kaysville, Utah, USA) were used for analysis. For evaluation of the study data, along with descriptive statistical methods, t-test and Mann–Whitney U test were used for intergroup parameters that were normally and not normally distributed, respectively. For intragroup evaluations, paired-t and Wilcoxon tests were used. The data related to age, sex, and observation period were evaluated using chi-square and t-tests. The results were shown at the 95% confidence interval, and significance was accepted at p=0.05.

## RESULTS

There were no statistical differences in chronological and skeletal ages between the treatment and control groups (p>0.05); however, the treatment periods were statistically different (p<0.05). Treatment period of the Modified Jasper Jumper

group was shorter than that of the face mask (p<0.01) and control groups (p<0.01) (Table 1). There were no statistically significant differences in sex distribution between the groups (p>0.05) (Table 1).

Mean values of the parameters before treatment are shown in Table 2. There were no statistically significant differences in parameters before treatment between the treatment and control groups, suggesting that the study groups are homogenous and comparable.

**Table 2.** Intergroup and intragroup comparison of the before and after treatment values of Modified Jasper Jumper, Face Mask, and control groups

| | | | MJJ | Face Mask | Control | |
|---|---|---|---|---|---|---|
| **Parameters** | | | **Ort±SD** | **Ort±SD** | **Ort±SD** | **p** |
| Pancherz Skeletal | ss/OLp (mm) | +Before Treatment | 69.84±4.02 | 70.72±3.50 | 69.07±3.79 | - |
| | | +After Treatment | 72.12±3.42 | 73.94±4.19 | 69.17±3.29 | 0.005** |
| | | ++B.T.-A.T. p | 0.001** | 0.001** | 0.157 | |
| | Pg/OLp (mm) | + Before Treatment | 74.20±4.96 | 76.23±3.44 | 74.00±5.65 | - |
| | | + After Treatment | 74.00±4.46 | 75.70±4.69 | 74.00±5.70 | - |
| | | ++ B.T.-A.T. p | 0.143 | 0.356 | 1.000 | |
| | Co/OLp (mm) | + Before Treatment | 12.18±1.94 | 10.88±2.17 | 11.00±2.45 | - |
| | | + After Treatment | 12.44±2.50 | 12.00±2.45 | 11.00±2.45 | - |
| | | ++ B.T.-A.T. p | 0.580 | 0.005** | 1.000 | |
| | Pg/OLp+Co/OLp (mm) | + Before Treatment | 85.60±3.69 | 87.11±3.60 | 85.23±4.93 | - |
| | | + After Treatment | 86.55±3.96 | 87.70±4.86 | 85.43±4.97 | - |
| | | ++ B.T.-A.T. p | 0.094 | 0.283 | 0.190 | |
| Pancherz Dental | is/OLp (mm) | + Before Treatment | 73.00±4.63 | 75.29±4.16 | 74.07±4.29 | - |
| | | + After Treatment | 77.00±4.05 | 78.51±4.68 | 74.17±4.10 | 0.032* |
| | | ++ B.T.-A.T. p | 0.001** | 0.001** | 0.170 | |
| | ii/OLp (mm) | + Before Treatment | 75.78±4.71 | 77.69±3.86 | 76.46±4.33 | - |
| | | + After Treatment | 75.00±4.41 | 75.58±5.04 | 76.46±4.29 | - |
| | | ++ B.T.-A.T. p | 0.329 | 0.006** | 1.000 | |
| | ms/OLp (mm) | + Before Treatment | 41.44±3.63 | 43.00±3.77 | 42.00±4.50 | - |
| | | + After Treatment | 45.28±3.30 | 47.25±5.18 | 42.10±4.30 | 0.005** |
| | | ++ B.T.-A.T. p | 0.001** | 0.001** | 0.165 | |
| | mi/OLp (mm) | + Before Treatment | 47.31±3.93 | 48.80±3.81 | 46.38±4.66 | - |
| | | + After Treatment | 46.21±4.25 | 48.00±5.34 | 46.30±4.66 | - |
| | | ++ B.T.-A.T. p | 0.337 | 0.725 | 0.907 | |
| Pancherz Skeletal-Dental | is/OLp-ii/OLp(mm) | + Before Treatment | -2.50±0.96 | -2.60±1.04 | -2.30±1.38 | - |
| | | + After Treatment | 2.28±1.89 | 2.72±1.54 | -2.45±1.45 | 0.001** |
| | | ++ B.T.-A.T. p | 0.001** | 0.001** | 0.157 | |
| | ms/OLp-mi/OLp (mm) | + Before Treatment | -5.87±2.60 | -5.95±1.70 | -4.48±1.25 | - |
| | | + After Treatment | -0.95±3.51 | -0.90±1.69 | -4.30±1.25 | 0.001** |
| | | ++ B.T.-A.T. p | 0.001** | 0.001** | 0.317 | |
| | is/OLp-ss/OLp (mm) | + Before Treatment | 3.25±1.61 | 4.47±2.18 | 5.23±1.09 | 0.011* |
| | | + After Treatment | 4.97±1.65 | 4.46±2.00 | 5.18±1.09 | - |
| | | ++ B.T.-A.T. p | 0.003** | 0.971 | 0.636 | |
| | ii/OLp-Pg/OLp (mm) | +Before Treatment | 1.68±1.92 | 1.35±2.26 | 2.30±1.93 | - |
| | | +After Treatment | 1.10±1.68 | -0.12±2.55 | 2.20±2.05 | 0.006** |
| | | ++ B.T.-A.T. p | 0.005** | 0.003** | 0.317 | |
| | ms/OLp-ss/OLp (mm) | +Before Treatment | -27.80±1.63 | -27.32±2.30 | -27.07±2.13 | - |
| | | +After Treatment | -26.23±2.25 | -26.29±3.19 | -27.07±2.14 | - |
| | | ++ B.T.-A.T. p | 0.001** | 0.019* | 1.000 | |
| | mi/OLp-Pg/OLp (mm) | +Before Treatment | -27.08±1.92 | -26.65±1.58 | -27.67±2.72 | - |
| | | +After Treatment | -27.98±2.74 | -26.92±2.23 | -27.75 ±3.09 | - |
| | | ++ B.T.-A.T. p | 0.050* | 0.042* | 0.180 | |

+One way ANOVA, ++Paired test, *p<0.05, **p<0.001

**Table 3.** Intergroup comparison of the changes in Modified Jasper Jumper, Face Mask, and control groups

| | | Modified Jasper Jumper | Face Mask | Control | Kruskal Wallis Test | Mann–Whitney U Test | | |
|---|---|---|---|---|---|---|---|---|
| | Parameters | M±SD | M±SD | M±SD | p | MJJ-FM | MJJ-C | FM-C |
| Pancherz Skeletal | ss/OLp | 2.28±1.51 | 3.22±1.83 | 0.10±0.50 | 0.001** | - | 0.001** | 0.001** |
| | Pg/OLp | -0.20±2.10 | -0.53±2.29 | 0.00±2.60 | 0.025 | - | - | - |
| | Co/OLp | 0.05±1.77 | 1.12±1.41 | 0.20±1.00 | 0.074 | - | - | - |
| | Pg/OLp+Co/OLp | 1.06±2.38 | 0.59±2.18 | 0.20±0.60 | 0.409 | - | - | - |
| Pancherz Dental | is/OLp | 4.00±2.35 | 3.21±1.80 | 0.10±0.00 | 0.001** | - | 0.001** | 0.001** |
| | ii/OLp | -0.78±2.72 | -2.11±2.65 | 0.00±0.37 | 0.024* | - | - | 0.003** |
| | ms/OLp | 3.85±2.62 | 4.25±2.55 | 0.10±0.00 | 0.001** | - | 0.001** | 0.001** |
| | mi/OLp | -1.1±2.77 | -0.80±2.70 | -0.08±0.10 | 0.536 | - | - | - |
| Pancherz Skeletal-Dental | is/OLp-ii/OLp | 4.78±1.96 | 5.32±2.04 | 0.15±0.37 | 0.001** | - | 0.001** | 0.001** |
| | ms/OLp-mi/OLp | 4.95±3.73 | 5.05±1.62 | 0.18±0.00 | 0.001** | - | 0.001** | 0.001** |
| | is/OLp-ss/OLp | 1.72±1.35 | 0.00±1.54 | -0.05±0.20 | 0.001** | 0.005** | 0.001** | - |
| | ii/OLp-Pg/OLp | -0.58±1.67 | -1.58±1.62 | -0.10±0.05 | 0.011* | - | 0.010* | 0.011* |
| | ms/OLp-ss/OLp | 1.57±2.03 | 1.03±2.21 | 0.00±0.00 | 0.001** | - | 0.001** | - |
| | mi/OLp-Pg/OLp | -0.90±2.30 | -0.27±1.65 | -0.08±0.90 | 0.146 | - | - | - |

*p<0.05, **p<0.001



**Table 4.** Comparison of treatment outcomes in Modified Jasper Jumper and Control groups

| | Modified Jasper Jumper | Control | Difference (Treatment Effect) | |
|---|---|---|---|---|
| Parameters | M±SD | M±SD | M±SD | p |
| ss/OLp (mm) (Maxillary Base) | 2.28±1.51 | 0.10±0.50 | 2.18±1.00 | 0.001** |
| Pg/OLp (mm) (Mandibular Base) | -0.20±2.30 | 0.00±2.60 | -0.20±2.50 | NS |
| is/OLp–ii/OLp (mm) (Overjet) | 4.78±1.96 | 0.15±0.37 | 4.63±1.57 | 0.001** |
| ms/OLp–mi/OLp (mm) (Molar Relation) | -4.95±1.03 | -0.18±0.00 | -4.77±1.00 | 0.001** |
| is/OLp–ss/OLp (mm) (Maxillary Incisor) | 1.72±1.35 | -0.05±0.20 | 1.77±0.80 | 0.001** |
| ii/OLp–pg/OLp (mm) (Mandibular Incisor) | -0.58±2.67 | -0.10±0.28 | -0.48±1.48 | 0.010* |
| ms/OLp–ss/OLp (mm) (Maxillary Molar) | 1.57±2.03 | 0.00±0.00 | 1.57±2.00 | 0.001** |
| mi/OLp–pg/OLp (mm) (Mandibular Molar) | -0.90±2.90 | -0.08±1.00 | -0.82±1.45 | NS |

Mann-Whitney U test was performed. NS: not significant; SD: standard deviation
*p<0.05 **p<0.001

In both treatment groups, while maxillary base moved forward (ss/OLp), upper incisors (is/OLp) and molar teeth (ms/OLp) also relatively moved forward (Table 2). When the increase in these three parameters was compared, the differences between the three groups were found to be statistically significant.

When the increase in these parameters in the treatment groups was compared with that in the control group, the differences were statistically significant (p<0.001; Table 3).

In the Modified Jasper Jumper group, anterior crossbite was improved due to protrusion of upper incisors (is/OLp–ss/OLp), retrusion of lower incisors (ii/OLp–Pg/OLp), and overjet increase (is/OLp–ii/OLp), and in face mask group, it was improved due to the retrusion of lower incisors (ii/OLp–Pg/OLp) and overjet increase (is/OLp–ii/OLp) (Table 2). Increase in the overjet and lower incisor retrusion was found to be statistically significant between the three groups (Table 3). Upper incisor protrusion (is/

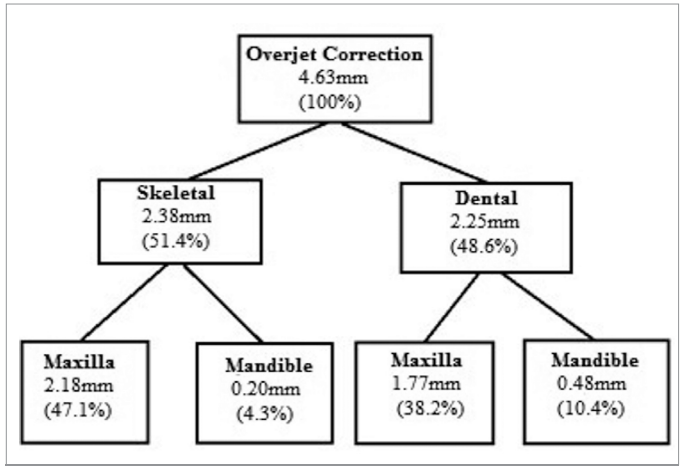


**Figure 5.** Diagram of maxillary and mandibular skeletal and dental changes contributing to overjet correction during treatment period in Modified Jasper Jumper treatment group

**Table 5.** Comparison of treatment outcomes in Face Mask and control groups

| | Face Mask | Control | Difference (Treatment Effect) | |
|---|---|---|---|---|
| **Parameters** | **M±SD** | **M±SD** | **M±SD** | **p** |
| ss/OLp (mm) (Maxillary Base) | 3.22±1.83 | 0.10±0.50 | 3.21±1.75 | 0.001** |
| Pg/OLp (mm) (Mandibular Base) | -0.53±2.29 | 0.00±2.60 | -0.53±2.40 | NS |
| is/OLp–ii/OLp (mm) (Overjet) | 5.32±0.54 | 0.15±0.37 | 5.17±0.50 | 0.001** |
| ms/OLp–mi/OLp (mm) (Molar Relation) | 5.00±1.82 | -0.18±0.00 | 4.87±1.80 | 0.001** |
| is/OLp–ss/OLp (mm) (Maxillary Incisor) | 0.00±1.54 | -0.05±0.20 | 0.05±0.70 | 0.001** |
| ii/OLp–pg/OLp (mm) (Mandibular Incisor) | -1.57±1.62 | -0.10±0.28 | -1.47±0.85 | 0.010* |
| ms/OLp–ss/OLp (mm) (Maxillary Molar) | 1.03±2.21 | 0.00±0.00 | 1.03±1.00 | 0.001** |
| mi/OLp–pg/OLp (mm) (Mandibular Molar) | -0.27±1.65 | -0.08±1.00 | -0.19±1.30 | NS |

Mann-Whitney U test was performed. NS: not significant; SD: standard deviation
*p<0.05, **p<0.001

OLp–ss/OLp) in the Modified Jasper Jumper group was found to be statistically significant when compared with that in the face mask and the control groups.

In Pancherz analysis, the change in overjet was considered as the difference between the distances is/OLp and ii/OLp. Overjet change in the Modified Jasper Jumper treatment group was calculated as 4.63 mm: 51.4% (2.38 mm) of this change was due to skeletal changes and 48.6% (2.25 mm) was due to dental changes. Further, 47.1% of skeletal changes were due to 2.18 mm forward movement of A point and 4.3% were due to 0.20 mm backward movement of B point; 38.2% of dental changes were due to 1.77 mm forward movement of upper incisors within the maxilla and 10.1% were due to 0.48 mm backward movement of lower incisors (Table 4, Figure 5).

Overjet change in the face mask treatment group was calculated as 5.17 mm; 70.6% (3.65 mm) of this change was due to skeletal changes and 29.4% (1.52 mm) was due to dental changes. Further, 60.3% of skeletal changes were due to 3.12 mm forward movement of A point and 10.3% were due to 0.53 mm backward movement of B point; 1.0% of dental changes were due to 0.05 mm forward movement of upper incisors within the maxilla and 28.4% were due to 1.47 mm backward movement of lower incisors (Table 5, Figure 6).

None of the parameters showed statistically significant differences in the control group (Table 2).

Improvement in Class III relationship in both treatment groups (ms/OLp–mi/OLp) (p<0.001) was due to forward movement of upper first molar (ms/OLp–ss/OLp) (p<0.001), and backward movement of lower first molar (mi/OLp–Pg/OLp) (p<0.05; Table 2).

Statistically significant difference in ms/OLp–mi/OLP parameter was found between three groups (p<0.001). When increase in ms/OLp–mi/OLp value in treatment groups was compared with that in the control group, the difference was found to be statistically significant (p<0.001). Statistically significant difference in ms/OLp–ss/OLp parameter was also found between three groups (p<0.001). When the increase in ms/OLp–ss/OLp distance in the Modified Jasper Jumper group was compared with that in the control group, statistically significant difference was found (p<0.001) (Table 3).

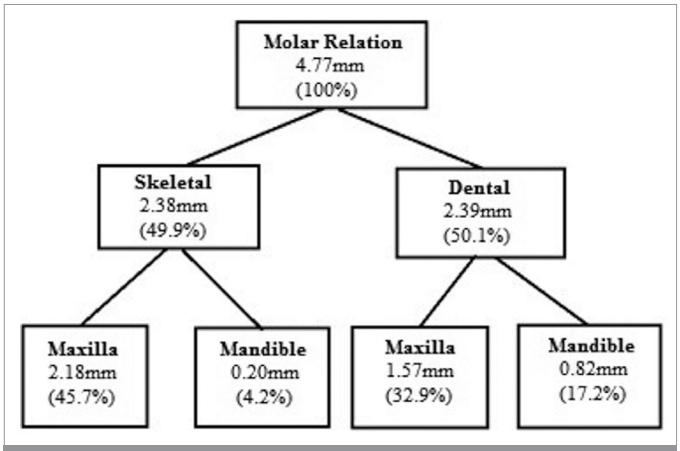


**Figure 6.** Diagram of maxillary and mandibular skeletal and dental changes contributing to molar correction during treatment period in Modified Jasper Jumper treatment group

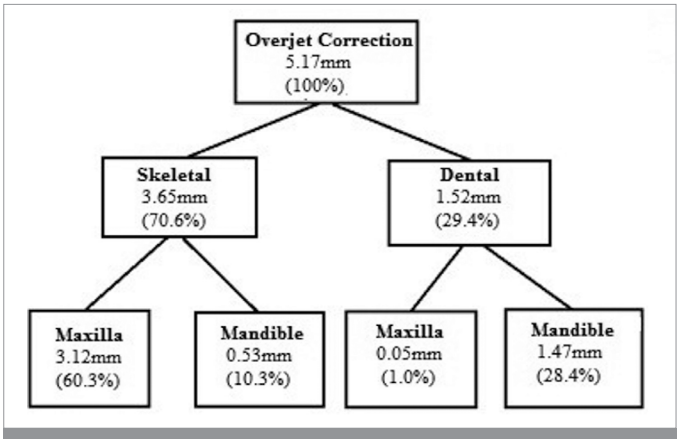


**Figure 7.** Diagram of maxillary and mandibular skeletal and dental changes contributing to overjet correction during treatment period in Face Mask treatment group

When comparing ms/OLp-ss/OLp parameter in the Modified Jasper Jumper treatment group with those in the control group, no statistically significant differences were found except the distal movement of lower molars (mi/OLp–Pg/OLp) (Table 3), and when comparing the changes in the face mask treatment group with those in the control group, no statistically significant differences

were found except the distal movement of lower molars (mi/OLp–Pg/OLp), forward movement of upper molars (ms/OLp–ss/OLp), and upper incisor protrusion (is/OLp–ss/OLp) (Table 3).

In the Modified Jasper Jumper treatment group, 49.9% (2.38 mm) of the total 4.77 mm change in molar relationship was due to skeletal changes and 50.1% (2.39 mm) was due to dental changes. Skeletal changes in the maxilla were 45.7%, which were due to 2.18 mm forward movement of A point. In the mandible, the skeletal change rate was 4.2%, which was due to 0.20 mm posterior positional change of the mandible. Regarding dental changes, 32.9% of total dental change (50.1%/2.39 mm) in the molar relationship was due to 1.57 mm forward movement of maxillary molars and 17.2% was due to 0.82 mm distal movement of lower molars (Table 4, Figure 7).

In the face mask treatment group, 75.0% (3.65 mm) of the total 4.87 mm change in the molar relationship was due to skeletal changes and 25.0% (1.22 mm) was due to dental changes. Skeletal changes in the maxilla were 64.1%, which were due to 3.12 mm forward movement of A point. In the mandible, the skeletal change rate was 10.9%, which was due to 0.53 mm posterior positional change of the mandible. Regarding dental changes, 21.1% of the total dental change (25.0 %/1.22 mm) in the molar relationship was due to 1.03 mm forward movement of maxillary molars and 3.9% was due to 0.19 mm distal movement of lower molars (Table 5, Figure 8).



## DISCUSSION

ss/OLp distance describes the position of the maxillary base. An increase of 2.28 mm in ss/OLp measurement in the Modified Jasper Jumper treatment group and 3.22 mm in the face mask group was considered to be statistically significant (Table 2). This finding shows the forward movement of maxillary base in both treatment groups. When the increase in ss/OLp was compared between treatment groups, there were no statistically significant differences, whereas the difference was statistically significant when the treatment groups were compared with the control group (Table 3). When comparing these findings with the results of the previous studies, which were on maxillary protraction with face mask 11'54, stimulation of maxilla in the horizontal direction is almost similar.

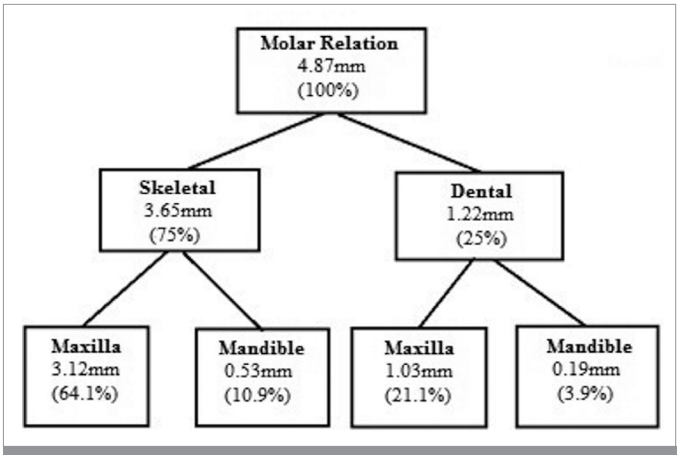


**Figure 8.** Diagram of maxillary and mandibular skeletal and dental changes contributing to molar correction during treatment period in Face Mask treatment group

A 1.12 mm increase in Co/OLp measurement in the face mask group was statistically significant. This may be due to the force applied on the chin by the chin part of the face mask that causes the condyle to take position backward and increase the distance between the Co point and the vertical reference plane. No statistically significant differences were found between three groups with respect to the condyle head position.

The distance of maxillary incisor and molar teeth from the vertical reference plane (OLp) was evaluated by the superimpositions. In the Modified Jasper Jumper group, a 4.00 mm increase in the is/OLp distance, which shows the maxillary incisor movement in the sagittal direction, and in the face mask group, a 3.21 mm increase were found to be statistically significant (Table 2). In the intergroup evaluation, the difference between the increase in both treatment groups and the increase in the control group was found to be statistically significant, whereas no statistical significance was found between the two treatment groups (Table 3).

With regard to ms/OLp distance, a 3.85 mm increase in the Modified Jasper Jumper group and 4.25 mm increase in the face mask group were found to be statistically significant (Table 2), indicating maxillary molar movement in the sagittal direction. In the intergroup evaluation, the difference between the increase in both treatment groups and the increase in the control group was statistically significant; however, there were no statistically significant differences between the two treatment groups (Table 3). According to these findings, it is determined that in both treatment groups upper incisors and first molars moved forward with the maxillary base owing to the protraction effect of the Modified Jasper Jumper appliance and Delaire face mask.

A 2.11 mm backward movement of lower incisors (ii/OLp) in face mask treatment group was statistically significant (Table 2). When this movement was compared to that of the control group, statistically significant differences were found. This finding in lower incisor movement is in accordance with the findings of Kajiyama et al. (15), Ngan et al. (16), Baccetti et al. (17), Gallagher et al. (18), Kapust et. al. (19), Sung and Baik (20), and Kilicoglu and Kirlic (21). It is determined that the movement in lower incisors is due to the force applied on lower incisors by the chin part of face mask.

Modified Jasper Jumper appliance creates a downward and backward force on lower molars and produces a counterclockwise movement of the lower dentition. Under these forces, the expected movement in the lower molar area is backward movement, distal tipping, and intrusion of lower molars and a decrease in occlusal plane inclination (22). In our study, lower molar-vertical reference line distance (mi/OLp) was measured for both groups and no significant change in this parameter was obtained. Usta's22 findings that showed backward movement of lower molars due to biomechanical effects of Modified Jasper Jumper appliance agree with our findings.

Pancherz (9) describes overjet change as the difference between is/OLp and ii/OLp distances. In our study, Modified Jasper Jumper treatment group's overjet change was calculated as 4.63 mm. (Table 4, Figure 5). According to these findings, skeletal and dental changes achieved by Modified Jasper Jumper treatment are almost equal, and in accordance to biomechanics of the appliance, a substantial part of these changes comes from maxilla (47.1%).

In the face mask treatment group, overjet change was calculated as 5.17 mm: 3.65 mm (70.6%) of this change was due to skeletal changes caused by 3.12 mm forward movement of A point and 0.53 mm backward movement of B point (Table 5, Figure 6). According to these findings, a substantial part of the overjet change in face mask treatment group comes from maxillary skeletal movement (60.3%) and a substantial part of the dental changes (28.4%) achieved from face mask treatment comes from the force applied on the chin by the chin part of the face mask. Ngan et al. (23) evaluated the overjet change in face mask treatment with Pancherz analysis and found that of total 6.2 mm change in overjet, 4.3 mm (%70) was due to skeletal changes, which is in accordance with our findings.

## CONCLUSION

In our study, dental and skeletal effects of Modified Jasper Jumper appliance and Delaire face mask used for Class III treatment in mixed dentition was evaluated by Pancherz analysis.

1. Treatment period of the Modified Jasper Jumper was shorter than that of the face mask
2. The maxillary base moved forward in both treatment groups, with the distance being more in the face mask group.
3. Maxillary incisor protrusion and forward movement was higher in the Modified Jasper Jumper group than in the face mask group.
4. In the Modified Jasper Jumper group, lower incisors were intruded, while they were extruded in the face mask group.
5. In the Modified Jasper Jumper treatment group, overjet change was calculated as 4.63 mm: 51.4% of this change was due to skeletal changes and 48.6% was due to dental changes. Further, 47.1% of skeletal changes were due to 2.18 mm forward movement of A point and 4.3% were due to 0.20 mm backward movement of B point.
6. In the face mask treatment group, the overjet change was calculated as 5.17 mm: 70.6% of this change was due to skeletal changes and 29.4% was due to dental changes. Further, 60.3% of skeletal changes were due to 3.12 mm forward movement of A point and 10.3% were due to 0.53 mm backward movement of B point.

In our study, it is determined that the face mask treatment caused more maxillary forward movement than the Modified Jasper Jumper treatment and both appliances were observed to be effective in the early treatment of Class III malocclusions. Therefore, the use of Modified Jasper Jumper appliance may be a good treatment alternative for patients showing poor cooperation.

**Ethics Committee Approval:** Ethics committee approval was received for this study from the ethics committee of İstanbul University School of Medicine.

**Informed Consent:** Written informed consent was obtained from the parents of the patients who participated in this study.

**Peer-review:** Externally peer-reviewed.

**Author Contributions:** Concept - H.K.; Design - H.K.; Supervision - H.K.; Resources - H.K.; Materials H.K.; Data Collection and/or Processing - H.K, C.A.U.; Analysis and/or Interpretation - H.K., C.A.U., N.Y.Ö.; Literature Search - H.K., C.A.U., N.Y.Ö.; Writing Manuscript - H.K., C.A.U., N.Y.Ö.; Critical Review - H.K., C.A.U., N.Y.Ö.

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