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Zorana Stamenković[1,♣], Vanja Stojić[1], Nemanja Marinković[1], Ivan Arsić[1], Jovan Marković[1], Bojan Glamočanin[2]

Changes during treatment of Class III malocclusion by Y appliance and appliance with screw according to Bertoni

Промене током третмана малколузија класе III применом апарата *Y* и апарата са шрафом по Бертонију

[1]University of Belgrade, School of Dental Medicine, Department of Orthodontics, Belgrade, Serbia;
[2]University of Novi Sad, Faculty of Medicine, Department of Dentistry, Novi Sad, Serbia

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♣**Correspondence to:**
Zorana STAMENKOVIĆ
Nevesinjska 12/I/5, 11000 Belgrade, Serbia
E mail: **zorana.stamenkovic@stomf.bg.ac.rs**

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SUMMARY

Introduction/Objective Class III malocclusion is caused by changes in skeletal and/or dentoalveolar structures with typical mesial relationship of posterior teeth. Y" appliance and appliance with screw according to Bertoni can be used in treatment of Class III caused by maxillary retrognathism in period of mixed dentition. The aim of study was to determine and compare changes on skeletal and dentoalveolar structures in patients with Class III treated by "Y" appliance and appliance with screw according to Bertoni.

Methods 40 patients with Class III were included in this study. Whole sample were divided in two groups, with 20 patients in each group. Including criteria were maxilarry retrognatism, period of mixed dentition and pubertal growth. Excluding criteria were mandibular prognatism, patients with genetical predisposition for skeletal Class III, patients with cleft lip and palate or craniofacial syndrome and period of permanent dentition. Appliances which caused mostly changes on the upper jaw were used in this study because all patients had deficience of maxillary growth. Anamnesis, clinical and functional testing, study casts analysis, analysis of orthopantomograms, lateral cephalograms, extraoral and intraoral photos have been done for each patient. Therapeutic effects were analysed on study casts and lateral cephalograms after this phase of orthodontic treatment.

Results Main dentoalveolar effect was protrusion of the upper incisors. Skeletal effects were not significant.

Conclusion Y appliance and appliance with screw according to Bertoni caused greater changes on dentoalveolar structures comparing to skeletal changes.

Keywords: Class III malocclusion; Y appliance; Bertoni screw

САЖЕТАК

Увод/Циљ Малоклузије III класе могу бити узроковане променама на скелетним и/или дентоалвеоларним структурама са мезијалним односом у регији бочних зуба. У раном третману класе III изазване максиларним ретрогнатизмом може се користити апарат *Y* и апарат са шрафом по Бертонију. Циљ овог истраживања је био да се утврде и упореде скелетне и дентоалвеоларне промене код пацијената са класом III који су лечени применом апарата *Y* и апарата са шрафом по Бертонију.

Методе У истраживање је укључено 40 пацијената. Цео узорак подељен је у две групе, са по 20 пацијената у свакој групи. У студију су укључени пацијенти код којих је узрок мезијалног загрижаја био максиларни ретрогнатизам, у мешовитој дентицији и пубертетском убрзању раста. Нису укључени пацијенти са правим мандибуларним прогнатизмом, особе са генетском предиспозицијом за настанак мезијалног загрижаја, пацијенти са расцепом усне и непца или неким краниофацијалним синдромом, као ни пацијенти са сталном дентицијом. Изабрани су апарати чија примена се базира на изазивању промена на структурама горње вилице. За пацијенте је урађена анамнеза, клиничко и функционално испитивање, анализа студијских модела, анализа ортопантомографског снимка и профилног цефалограма, као и екстраоралних и интраоралних фотографија. Терапијски ефекти анализирани су на студијским моделима и профилним цефалограмима, урађеним након ове фазе ортодонтског третмана.

Резултати Главни дентоалвеоларни ефекат била је протрузија горњих секутића. Скелетни ефекти нису били значајни.

Закључак Апарат *Y* и апарат са шрафом по Бертонију изазивају значајне промене на дентоалвеоларним структурама у поређењу са скелетним структурама, где су промене биле мање уочљиве.

Кључне речи: малоклузије III класе; апарат *Y*; апарат са шрафом по Бертонију

INTRODUCTION

Class III malocclusion is orthodontic problem in sagittal direction with mesial relationship of posterior teeth. The cause of this malocclusion could be changes in skeletal and/or dentaoalveolar structures [1]. Skeletal form of Class III can be caused by maxillary retrognathism and underdeveloped upper jaw, mandibular prognathism and overdeveloped lower jaw and combination of these two changes. Patients with skeletal Class III caused by maxillary retrognathism have typical concave profile and backward position of the upper jaw and upper lip [1]. Upper jaw is underdeveloped in sagittal and transversal direction. Patients with cleft lip and palate and some syndromes (Apert, Crouzon) often have mesial bite due to insufficient growth of the upper jaw. Frequency of this malocclusion increases during the time [2, 3]. The prevalence of skeletal mesial bite in deciduous dentition is 23%, in mixed dentition 30% and in permanent dentition 34% [1].

Y appliance is active removable orthodontic appliance. This appliance has acrylic plate cut in the shape of letter "Y" with two screws in the area of canine. Main effect of appliance is protrusion of the upper incisors if patient turns both screws in the same time. This appliance is useful in treatment of patients with Class III caused by maxillary retrognathism during mixed dentition [4].

Appliance with screw according to Bertoni is active, mobile orthodontic appliance. This appliance has special screw which acts in two directions (sagittal and transversal). Appliance is useful in treatment of patients with insufficient growth of the upper jaw. Screw can consist of two or three guides. One screw causes protrusion of the upper incisors, while the other one or two screws (depends on design) cause transversal expansion of the upper dental arch. Patients turn screws at a different time [4].

The aim of this investigation was to determine and compare skeletal and dentoalveolar changes in patients with Class III treated with "Y" appliance and appliance with screw according to Bertoni.

METHODS

In this retrospective study 40 patients of Department of Orthodontics, School of Dental Medicine, University of Belgrade were included. This study was approved by the Ethics

Committee, School of Dental Medicine, University of Belgrade, Serbia (No. 10/1). None of the patients had previous orthodontic treatment. This sample included patients with decreased value of ANB angle (less than 2°) caused by maxillary retrognathism (angle SNA less than 82º).

Patients were divided in two following groups: group I patients treated with ''Y'' appliance (20 patients) (Figure 1) and group II patients treated by appliance with screw according to Bertoni (20 patients) (Figure 2). "Y" appliance and appliance with screw according to Bertoni were worn 16 to 18 hours during the day. In "Y" appliance screws were turned at the same time, while in appliance with screw according to Bertoni screws were turned at different times. Appliance with screw according to Bertoni was used in patients with narrow upper arch and retrusion of the upper incisors, while "Y" appliance was used in patients with retrusion of upper incisors without deficient growth of the upper jaw in transversal direction. The active phase of treatment lasted 18 months.

These appliances can be used during treatment of skeletal Class III caused by maxillary retrognathism.

All patients were in period of mixed dentition, during pubertal growth spurt period. Average chronological age in group I was 9 years and 2 months and in group II 9 years and 9 months. Dental age was determined according to Demirjian's method. Average dental age in group I was 9 years and 7 months and in group II 9 years and 11 months. Skeletal age was estimated by Baccetti method of cervical vertebral maturation [5]. In group I 3 patient (15%) were in stage 1, 11 patients (55%) in stage 2 and 6 patients (30%) in stage 3. In group II 4 patients (20%) were in stage 1, 12 patients (60%) in stage 2 and 4 patients (20%) in stage 3. The average duration of orthodontic treatment was 17 months in group I and 20 months in group II. Chronological, dental and skeletal age, duration of treatment and sex distribution are shown in Table 1.

Including criteria were maxilarry retrognatism, period of mixed dentition, positive overjet, mesial byte and age in correlation with the best period for treatment for each appliance. Excluding criteria were patients with cleft lip and palate or some craniofacial syndrome, mandibular prognatism, permanent dentition, late age for this kind of treatment or premature contact during moving of the lower jaw from physiological rest to central occlusion. No one patient witdrew from the therapeutic procedure. Only patients with a complete treatment

protocol were included in this study. Patients with a genetic predisposition to this malocclusion were not included.

Diagnostic procedure has been done for each patient before orthodontic treatment. Diagnostic procedure included anamnesis, clinical and functional testing, study casts analysis, analysis of orthopantomograms, lateral cephalograms, extraoral and intraoral photos. Lateral cephalograms and study casts were done after this phase of orthodontic treatment to assess therapeutic effects of each used appliance.

Cephalometric parameters:

The following parameters were included and analyzed:

- angle SNA – sagittal position of the upper jaw
- angle SNB – sagittal position of the lower jaw
- angle ANB – relation between upper and lower jaw in sagittal direction
- angle SpP/MP – vertical position of the upper jaw
- angle SN/SpP – vertical position of the lower jaw
- angle SN/MP – relation between upper and lower jaw in vertical direction
- sum of angles of Bjork`s polygon – type of facial growth
- relation between anterior and posterior facial height – type of facial growth
- distance Sna-A' – length of the maxillary corpus
- distance Pg'-Go' – length of the mandibular corpus
- distance Cd'-Go' – height of the mandibular ramus
- angle I/SpP – inclination of upper incisors
- angle i/MP – inclination of lower incisors.

Manual drawing and analysis of lateral cephalogram was done. Computer analysis has not been done. The measurements were made by one impartial researcher. The researcher had no insight into which group of patients he was analyzing.

Statistical analysis

Statistical analysis included mean values, maximum and minimum value and standard deviation, as a part of standard descriptive statistical analysis. Two-factor analysis of the variance with repeated measuring was used in relation to the factor time and factor time and group allocation. ANOVA, Wilcoxon matched pairs test and Student's t-test were used for determining the statistical significance of acquired differences. SPSS18.0, IBM Statistics, USA was used.

RESULTS

Parameters in sagittal direction

Both appliances caused increased value of SNA angle. We used two factor analysis of the variance with repeating measuring to determine effects of two removable appliances on the sagittal position of the upper jaw before and after orthodontic treatment. Statistically significant differences between these two periods were evaluated in both groups. Value of SNB angle increased in both groups of patients. Statistically significant difference was determined only in group of patients treated by Y appliance. Increasing value of SNB angle is a direct consequence of the mandibular growth which is very intense at this age. The ANB angle increased significantly in both groups. Student's t-test and Wilcoxon matched paired test indicated significant differences in both groups (Table 2).

Parameters in vertical direction

Value of SN/SpP angle increased in both group of patients. When we compared two group of patients only Y appliance caused statistically significant changes of SN/SpP angle during treatment. The SN/MP angle increased insignificantly in group treated with Y appliance

and Bertoni's screw. When we compared groups after treatment we evaluated significant changes. Both appliances caused an increase of SpP/MP angle. Statistically significant differences existed in both groups when we compared values before and after treatment (Table 3).

Parameters of maxillary and mandibular development

Length of the upper jaw increased significantly during treatment with both appliances. Two factor analysis of the variance with repeated measures determined a statistically significant differences in the pretreatment and posttreatment values of the length of upper jaw. Length of the lower jaw increased in both groups. Height of mandibular ramus increased in both treated group of patients. Statistically significant differences determined by comparison of both groups of patients were also evaluated (Table 4).

Parameters of facial growth

Sum of angles of Bjork's polygon increased in both groups of patients. There were no significant differences between groups during treatment. Relation between anterior and posterior facial height decreased in group treated with appliance with Bertoni's screw, while increased in group treated with Y appliance. There were no statistically significant changes between groups and during treatment (Table 5).

Dentoalveolar parameters

Angle I/SpP was decreased in both group of patients. Two factor analysis of variance with repeated measures determined statistically significant difference in group treated with Y appliance and appliance with Bertoni's screw. When comparing effects of treatment, significant differences existed in both treated groups. Angle i/MP increased in group treated with appliance with Bertoni's screw, while Y appliance caused insignificant decrease of this angle. Statistically significant changes in both groups were evaluated with two factor analysis of the variance with repeated measures (Table 6).

DISCUSSION

Early treatment of skeletal Class III caused by maxillary retrognathism can provide correct occlusion, functional stability and acceptable facial aesthetics. At the same time, we can avoid the need for a later complex and expensive orthodontic treatment or combined orthodontic and surgical treatment [6]. For this reason, the most important are effects on the skeletal structures of the upper jaw. It was very important to determine scope of changes on skeletal and dentoalveolar structures depending on the used appliances and the mechanism of their application. All patients in this study were in period of pubertal acceleration of growth, without earlier orthodontic treatment. Patients included in this study were treated at the Department of Orthodontic, School of Dental Medicine, University of Belgrade. Standard diagnostic procedure included: anamnesis, clinical and functional examinations, analysis of study casts, orthopantomograms and lateral cephalograms, extraoral and intraoral photos. All patients were divided in two groups according to type of used appliance: group I treated by "Y" appliance and group II treated by removable appliance with screw according to Bertoni. In some cases, fixed appliance 4 × 2 can be used, for example in patients with allergy reaction to materials used for mobile appliances, in patients with epilepsy or in cases with cancer who need frequent and repeated MRI. Also, for significant anterior growth of the upper jaw and skeletal effects in early treatment can be used Fränkel functional regulator type III [7–10].

Position and development of the upper jaw were analyzed using values of angles SNA and SN/SpP and linear distance Cmax which determined length of the upper jaw. Increase of maxillary corpus length was a result of simultaneously intensive pubertal growth and effects of orthodontic appliance. Stimulation of sagittal growth of the upper jaw caused forward moving of point A. This moving caused increase of SNA angle. Also, both appliance caused expansion of the upper dental arch which was in correlation with posterior rotation of the lower jaw and the distal movement of point B. [8, 9, 11]. Vertical position of the upper jaw was changed according to increased value of angle SN/SpP [12, 13].

There was far less effect on the lower jaw than on the upper jaw. "Y" appliance and appliance with screw according to Bertoni did not have influence on the position of the lower jaw, because these appliances were located only in the upper jaw. These devices were used precisely because the essence of the problem was the underdevelopment of the upper jaw.

Relationship between upper and lower jaw was evaluated by values of angles ANB and SpP/MP. Both appliances caused significant increase in value of ANB angle, so it changed

skeletal Class III to skeletal Class I thanks to anterior movement of point A [14, 15]. Increased value of angle ANB was a consequence of increased angle SNA [9, 16, 17]. Y appliance and appliance with screw according to Bertoni mostly affected dentoalveolar structures, while skeletal changes were minimal [4, 18, 19].

Facial growth was analyzed by Björk and Jarabak method. Generally, treatment with both appliances caused slight backward facial rotation and tendency to the vertical facial growth [8, 20, 21, 22].

Position of the upper incisors was evaluated by angle I/SpP. Mostly, patients with Class III (except patients with real mandibular prognathism) had normoinclination of the upper incisors [8,12]. Used appliances changed inclination of the upper incisors, with protrusion of these teeth [21, 22]. It was a consequence of design of these appliances, which were located only on the upper dental arch. Dentoalveolar effects that corrected the overjet were protrusion of the upper incisors and retrusion of the lower incisors [14, 23, 24]. Retrusion of the lower incisors was not a concequence of orthodontic treatment. It was some kind of dentoalveolar compensation. Active mobile appliances caused more intense changes on dentoalveolar structures, with severe proclination of the upper incisors [9, 13, 16] (Figure 3, Figure 4).

Changes in dentoalveolar and skeletal structures, are accompanied by an improvement in overall facial aesthetics, which has been confirmed by numerous studies [14, 18, 25, 26].

CONCLUSION

This study indicated that “Y” appliance and upper appliance with screw according to Bertoni caused more dental changes during treatment of Class III malocclusion caused by maxillary retrognathism. Treatment with “Y” appliance and appliance with Bertoni's screw mostly caused changes in dentoalveolar structures. These two appliances contributed to the correction of negative overjet due to protrusion of the upper incisors. The use of these removable appliances can be useful in early correction of skeletal Class III. Active mobile appliances, Y appliance and appliance with screw according to Bertoni, did not caused significant changes on skeletal structures of craniofacial complex.

Conflict of interest: None declared.

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Table 1. Chronological, dental and skeletal age, treatment time and distribution by sex

Appliance	Chronological age	Dental age	Skeletal age	Treatment time	Sex	
					Male	Female
Y n = 20	9 y 2 m	9 y 7 m	Stage 1 (n = 3) Stage 2 (n = 11) Stage 3 (n = 6)	17 months	11	9
Bertoni n = 20	9 y 9 m	9 y 11 m	Stage 1 (n = 4) Stage 2 (n = 12) Stage 3 (n = 4)	20 months	13	7

Table 2. Parameters in sagittal direction – changes during treatment with different appliances

Parameter	T1 x ± SD	T2 x ± SD	Δ (T2-T1) x ± SD	Significance[a] at T1	Significance[a] at T2	Significance[b/c]	Significance[d]	Significance[e]
SNA (°)								
Y app n = 20	76.60 ± 1.96	77.90 ± 1.86	1.30 ± 0.66			p = 0.000*	p < 0.001*	
Bertoni app n = 20	76.80 ± 1.83	77.85 ± 1.92	1.05 ± 1.84	0.660	0.939	p = 0.000*	p < 0.001*	
SNB (°)								
Y app n = 20	79.00 ± 1.92	79.45 ± 1.70	0.45 ± 1.85			p = 0.089	p = 0.004*	
Bertoni app n = 20	79.20 ± 2.12	79.50 ± 1.93	0.30 ± 2.06	0.159	0.204	p = 0.078	p = 0.307	
ANB (°)								
Y app n = 20	-2.40 ± 1.09	-1.55 ± 1.19	0.85 ± 0.99			p = 0.065	p = 0.000*	p = 0.007*
Bertoni app n = 20	-1.80 ± 1.95	-1.35 ± 1.64	0.45 1.92	0.450	0.033*	p = 0.123	p = 0.102	p = 0.012*

*statistically significant difference;

[a]monofactorial variance analysis;

[b]two-factor analysis of the variance, factor time;

[c b]two-factor analysis of the variance, factor time-group;

[d]t-test;

[e]Wilcoxon matched pairs test

Table 3. Parameters in vertical direction – changes during treatment with different appliances

Parameter	T1 x ± SD	T2 x ± SD	Δ (T2-T1) x ± SD	Significance[a] at T1	Significance[a] at T2	Significance[b/c]	Significance[d]
SN/SpP (°)							
Y app n = 20	11.75 ± 1.55	12.75 ± 1.48	1.00 ± 1.21			p = 0.228	p = 0.002*
Bertoni app n = 20	11.20 ± 2.14	11.60 ± 2.23	0.40 ± 2.02	0.005*	0.001*	p = 0.334	p = 0.136
SN/MP (°)							
Y app n = 20	36.85 ± 5.02	38.90 ± 4.34	2.05 ± 2.39			p = 0.245	p = 0.001*
Bertoni app n = 20	36.25 ± 4.83	37.85 ± 4.12	1.60 ± 2.23	0.587	0.769	p = 0.173	p = 0.003*
SpP/MP (°)							
Y app n = 20	25.05 ± 4.86	26.15 ± 4.26	1.10 ± 1.86			p = 0.999	p = 0.016*
Bertoni app n = 20	24.75 ± 4.18	25.55 ± 3.92	0.80 ± 3.23	0.891	0.549	p = 0.712	p = 0.012*

*statistically significant difference;

[a]monofactorial variance analysis;

[b]two-factor analysis of the variance, factor time;

[c b]two-factor analysis of the variance, factor time-group;

[d]t-test

Table 4. Maxillary and mandibular development – changes during treatment with different appliances

Parameter	T1 x ± SD	T2 x ± SD	Δ (T2-T1) x ± SD	Significance[a] at T1	Significance[a] at T2	Significance[b/c]	Significance[d]
Cmax (mm)							
Y app n = 20	46.87 ± 2.04	48.35 ± 2.11	1.48 ± 0.75			p = 0.000*	p<0.001*
Bertoni app n = 20	45.10 ± 2.17	46.20 ± 2.05	1.00 ± 1.93	0.471	0.690	p = 0.014*	p<0.001*
Cmand (mm)							
Y app n = 20	73.55 ± 3.72	74.75 ± 3.48	1.20 ± 0.94			p = 0.941	p<0.001*
Bertoni app n = 20	71.10 ± 3.43	72.20 ± 3.18	1.10 ± 2.67	0.742	0.970	p = 0.726	p = 0.114
Rmand (mm)							
Y app n = 20	54.15 ± 2.37	54.95 ± 2.23	0.80 ± 0.95			p = 0.771	p = 0.001*
Bertoni app n = 20	53.10 ± 2.25	53.85 ± 2.02	0.75 ± 2.11	0.092	0.075	p = 0.675	p = 0.043*

*statistically significant difference;

[a]monofactorial variance analysis;

[b]two-factor analysis of the variance, factor time;

[c b]two-factor analysis of the variance, factor time-group;

[d]t-test

Table 5. Parameters of facial growth – changes during treatment with different appliances

Parameter	T1 x ± SD	T2 x ± SD	Δ (T2-T1) x ± SD	Significance[a] at T1	Significance[a] at T2	Significance[b/c]	Significance[d]
∑ Bjork (°)							
Y app n = 20	394.05 ± 4.50	395.05 ± 4.26	1.00 ± 2.34	0.359	0.669	p = 0.599	p = 0.071
Bertoni app n = 20	394.70 ± 4.14	395.50 ± 3.83	0.80 ± 3.26			p = 0.634	p = 0.142
SGo/NMe × 100 (%)							
Y app n = 20	63.73 ± 1.70	64.30 ± 2.84	0.57 ± 1.74	0.237	0.132	p = 0.328	p = 0.555
Bertoni app n = 20	63.50 ± 2.20	63.10 ± 2.36	0.40 ± 2.45			p = 0.423	p = 0.478

*statistically significant difference;

[a]monofactorial variance analysis;

[b]two-factor analysis of the variance, factor time;

[c b]two-factor analysis of the variance, factor time-group;

[d]t-test

Table 6. Dentoalveolar parameters – changes during treatment with different appliances

Parameter	T1 x ± SD	T2 x ± SD	Δ (T2-T1) x ± SD	Significance[a] at T1	Significance[a] at T2	Significance[b/c]	Significance[d]
I/SpP (°)							
Y app n = 20	71.30 ± 2.81	68.70 ± 3.06	2.60 ± 1.05	0.420	0.015*	p = 0.000*	p < 0.001*
Bertoni app n = 20	72.20 ± 2.53	70.10 ± 2.37	2.10 ± 1.87			p = 0.007*	p < 0.001*
i/MP (°)							
Y app n = 20	90.15 ± 2.83	90.05 ± 2.46	0.10 ± 1.07	0.406	0.705	p = 0.000*	p = 0.681
Bertoni app n = 20	89.70 ± 2.18	90.10 ± 2.45	0.40 ± 1.67			p = 0.012*	p = 0.437

*statistically significant difference;

[a]monofactorial variance analysis;

[b]two-factor analysis of the variance, factor time;

[c b]two-factor analysis of the variance, factor time-group;

[d]t-test;

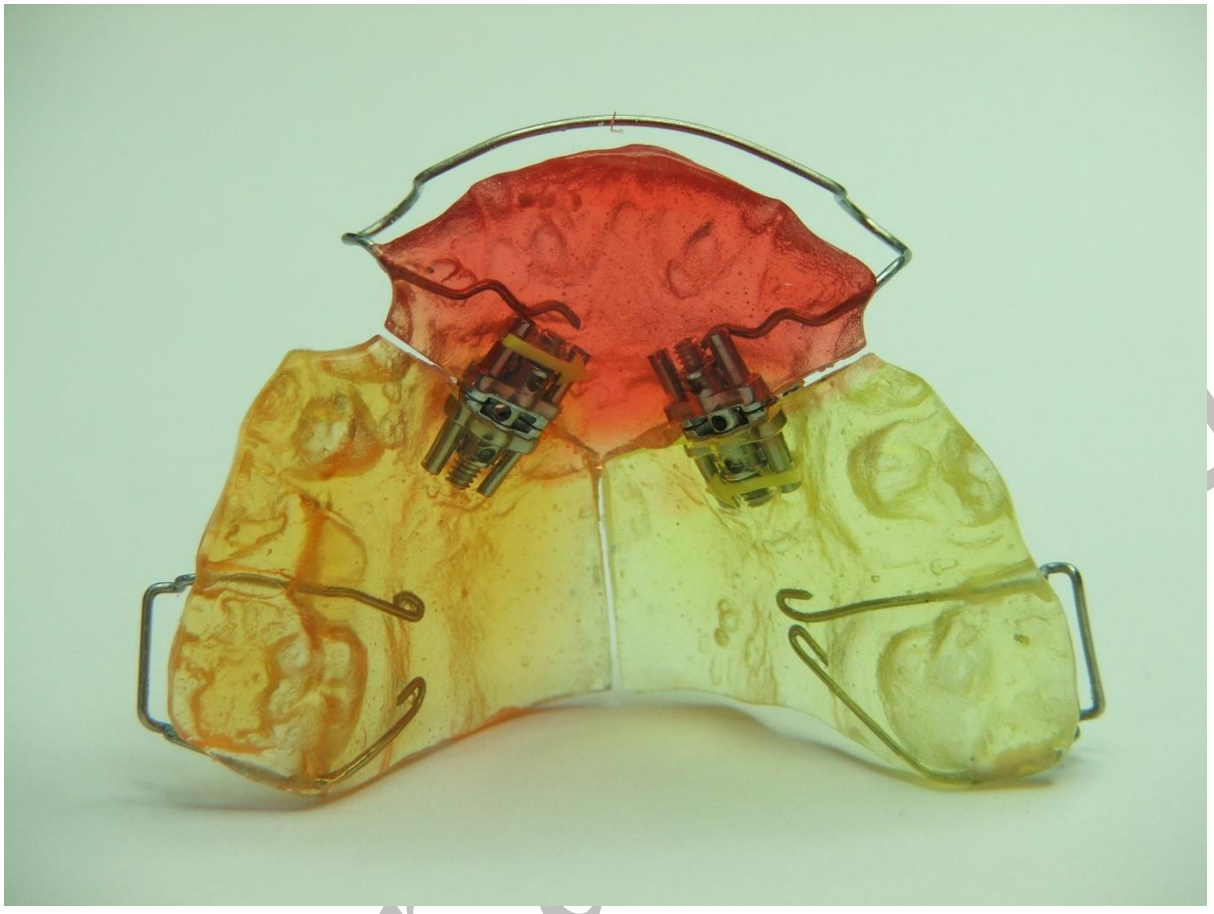

Figure 1. "Y" appliance

Figure 2. Appliance with screw according to Bertoni

Figure 3. Intraoral photos before and after treatment with appliance with screw according to Bertoni

Figure 4. Intraoral photos before and after treatment with "Y" appliance

