

# CLINICAL CASES

Dent. Med. Probl. 2014, 51, 2, 265–274  
ISSN 1644-387X

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KAMILA KOCENT<sup>1, A-D</sup>, RYSZARD KOCZOROWSKI<sup>2, A, C, D-F</sup>

## The Use of the Herbst Appliance in the Treatment of Adult Patients with Skeletal Class II Malocclusion

### Zastosowanie aparatu Herbsta w leczeniu dorosłych pacjentów z II klasą szkieletową

<sup>1</sup> Specialist Dental Clinic NORDENT, Poznań, Poland

<sup>2</sup> Department of Gerodontology, Poznan University of Medical Sciences, Poznań, Poland

A – research concept and design; B – collection and/or assembly of data; C – data analysis and interpretation; D – writing the article; E – critical revision of the article; F – final approval of article

#### Abstract

The growing number of adult patients interested in orthodontic treatment for aesthetic and health-related reasons has been a subject of numerous discussions among dentists dealing with the improvement of external appearance. The Herbst appliance, also known as the Herbst hinge, is one of the alternative methods of orthodontic treatment for adult patients with skeletal class II malocclusion. On account of its mechanism, the Herbst appliance is compared to an artificial temporomandibular joint. The paper presents adult therapy cases in which the aforementioned appliance has been used. The authors discuss its advantages, working principle and therapeutic procedures related to the Herbst appliance which, though first introduced in the early 20<sup>th</sup> century, has recently enjoyed a revival. Cemented on selected teeth, the appliance works continuously and, other than proper hygiene care, it does not require particular attention from the patient. The authors present the state of the masticatory organ prior to and following the treatment involving the appliance. Several years of patient observation by the attending orthodontist warrant the recognition of this therapeutic method as highly useful in treating skeletal class II malocclusion type owing to its immediate, lasting and satisfying aesthetic results (*Dent. Med. Probl.* 2014, 51, 2, 265–274).

**Key words:** Herbst appliance, malocclusion, skeletal class II, orthodontic treatment of adults.

#### Streszczenie

Zwiększenie liczby dorosłych pacjentów zainteresowanych leczeniem ortodontycznym zarówno z przyczyn estetycznych, jak i zdrowotnych jest tematem licznych dyskusji stomatologów zajmujących się poprawą zewnętrznego wizerunku. Aparat Herbsta zwany zawiasem Herbsta jest jedną z alternatywnych metod ortodontycznej terapii pacjentów z II klasą szkieletową. Ze względu na mechanizm działania jest porównywany do sztucznej formy stawu skroniowo-żuchwowego. Celem pracy jest przedstawienie przypadków leczenia dorosłych pacjentów z zastosowaniem wyżej wymienionego aparatu. Autorzy przedstawiają zalety, mechanizm działania i procedury lecznicze związane z aparatem Herbsta, który choć został po raz pierwszy zaprezentowany na początku XX w., to obecnie przeżywa swój renesans. Zacementowany na wybranych zębach aparat działa przez 24 godziny na dobę i oprócz zapewnienia dobrej higieny nie wymaga koniecznej współpracy ze strony pacjenta. Autorzy opisują stan narządu żucia przed leczeniem z użyciem tego aparatu i po leczeniu. Kilkuletnie monitorowanie wielu pacjentów przez prowadzącego lekarza ortodontę pozwala uznać tę metodę terapii za bardzo przydatną w leczeniu wymienionej wady zgryzu z uwagi na szybkie, długotrwałe i satysfakcjonujące efekty estetyczne (*Dent. Med. Probl.* 2014, 51, 2, 265–274).

**Słowa kluczowe:** aparat Herbsta, wady zgryzu, klasa II szkieletowa, leczenie ortodontyczne dorosłych.

Modern day orthodontic treatment based on the latest technologies enables the achievement of fully satisfying effects to both the patients and their dentist, using various techniques and methods. Apart

from the broadly defined ideal treatment results, patients expect reductions in therapy time and expenditure. There has been an increase in the number of adult patients who are interested in orthodontic

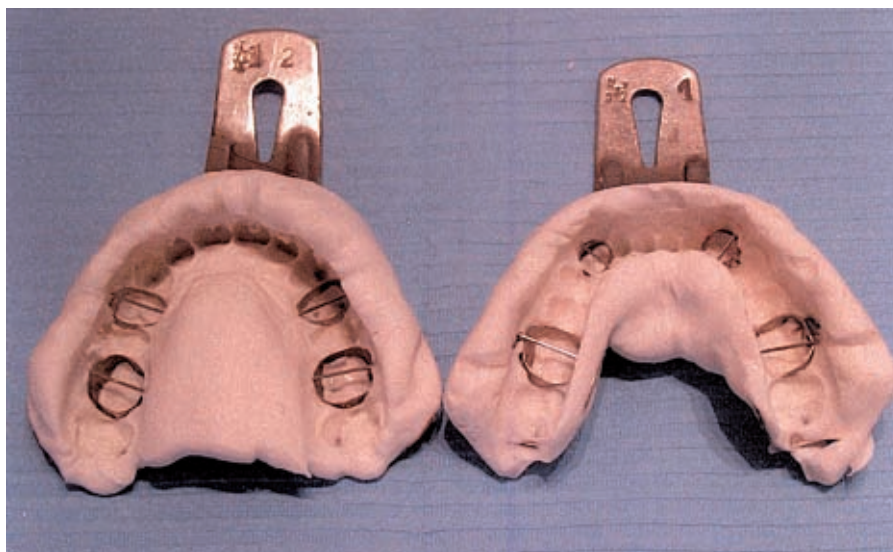
treatment for both aesthetic and health-related reasons [1–3]. Some of the most commonly used treatment methods in skeletal class II malocclusion (posterooclusion) patients include the following:

- fitting of ribbon arch appliances with elastic class II traction,
- use of orthodontic camouflage, which requires the extraction of the upper two premolars and the retraction of the upper incisors,
- treatment of serious class II cases associated with a surgical procedure [4, 5].

Contrary to adolescent patients, adult patients have lost the benefit of growth spurts, which involve the most noticeable mandible growth as well as orthognatic difficulties. The recommended class II elastic traction types are not always conducive to the attainment of the anticipated effect, i.e. forward mandible growth, and the frequent lack of discipline in wearing them additionally hinders the quick achievement of therapeutic goals. The extraction of the first premolars in the upper arch does not improve the patient's profile, nor does it broaden their upper respiratory tract or eliminate speech defects. When proposed treatment associated with orthognatic surgery, patients frequently decline to undergo the prospective procedure, often claiming that backward mandible positioning does not affect the quality of their lives, thus deciding to merely align their teeth so as to harmonize their dental arches. Therefore, the following question arises: what type of treatment should be employed in order to treat a skeletal class II patient as quickly and effectively as possible while ensuring a satisfying aesthetic result?

One of the effective methods of orthodontic therapy can be the increasingly frequent use

of the Herbst appliance, also known as the Herbst hinge [2, 4, 6–8] (Fig. 1). First presented in 1909 at the International Dental Congress in Berlin, this functional appliance is currently enjoying a major revival, gaining increasingly numerous ranks of proponents thanks to its high success rate. Reintroduced in the 1970 and used extensively by Pancherz, the Herbst appliance restores the backward positioning of the mandible to its frontal position, both for occluded and unoccluded dental arches. The position of the lips and tongue changes along with the action of the entire group of masticatory organ muscles. Thus, this appliance is referred to as functional appliance [6, 9]. In their assumptions concerning functional orthodontics, Andresen and Häupl, followed by Fränkel and Balters, formulated the principles of functional adjustment within the limits of the masticatory organ [9]. The main problem they encountered using removable functional appliances was the short stimulus functioning period, where a lasting frontal mandible repositioning constitutes a precondition for success. Removable orthodontic appliances tend to be removed by the patient in a number of situations on a daily basis, hence the inconsistent duration of their impact. Cemented on selected teeth, the Herbst appliance functions continuously and, other than proper hygiene care, it does not require particular attention from the patient. The appliance works uninterruptedly 24 hours a day, during each activity undertaken by the mastication apparatus and may be compared to an artificial form of the temporomandibular joint. Since the appliance is equipped with a two-sided, stiff telescopic mechanism, the mandibular condylar process situates itself on the slope of the articular tubercle of the temporal bone



**Fig. 1.** Anatomical impressions taken with orthodontic bands fitted around abutment teeth in the oral cavity

**Ryc.1.** Wyciski anatomiczne pobrane z pierścieniami dopasowanymi w jamie ustnej do zębów filarowych

and hence limits its retraction. This ensures correct blood flow in the temporo-mandibular joint and proper conditions for its restructuring [5, 8, 10, 11]. In removable appliances, throughout the day the condyle engages in interchangeable forward motion onto the articular tubercle slope during its attachment and backward motion accompanying its removal. This causes the reduction of the blood flow within the joint, thus impeding the restructuring process. The Herbst appliance may at once alter significant overjet (even as large as 10–15 mm), while with removable functional appliances the process occurs gradually and to a limited extent. The imposed forward position of the mandible causes the muscles which retract it, i.e. the temporal muscle and suprahyoid muscles to remain active in the first 3–4 days following the fitting of the Herbst appliance. The telescopic mechanism, however, prevents the mandible from retracting and, as a result, after the aforementioned period of time the muscle tension subsides. This phenomenon may be compared to a weightlifter sustaining a weight above their head. After a short period of time and due to muscle fatigue and decreased muscle tension, the weightlifter drops the weight onto the supporting rack. Paulsen [12] – an avid supporter of the discussed method – stresses that as soon as 3 months following the application of the hinge new bone structures can be observed within temporo-mandibular joints, also among patients past the peak of their growth periods. Manzo [7] argues that the percentage of failed treatments and the predictability of treatment results are comparable to the results of orthognathic procedures, one of the appliance's benefits being the possibility to obtain class I relation in posterior regions within a period of no more than 10 months. During the Herbst appliance therapy, the upper incisors ought to be aligned so as to gently bite over (overlap with) the lower incisors. They should not, however, be placed in a *tête-à-tête* position. The alignment of class I canines is a condition for the avoidance of recidivism following the conclusion of active treatment. Throughout the Herbst appliance treatment, orthodontists should take into consideration the following alterations in the positioning of teeth on both dental arches:

- upper jaw molars will distal, while mandibular molars will be placed mesially,
- mandibular incisors will be inclined,
- upper jaw molars will be intruded, with mandibular molars extruded, as a result leading to the reduction of the excessive overbite.

The aforementioned will be conducive to treating low angle skeletal class II. With high angle patients, the decision to employ the Herbst appliance should be reconsidered.

It should be noted that skeletal class II patients qualified for treatment using permanent functional appliances ought to be informed of any possible inconvenience such as:

- hindrances to the maintenance of oral cavity hygiene,
- discomfort related to the irritation of the oral cavity mucus membrane (abrasions, ulcers),
- restriction of lateral mandible movement,
- hindrances to proper pronunciation and chewing (initial treatment stage),
- mechanical malfunctions such as the disconnection of the telescopic mechanism and cracking of orthodontic bands (following their overheating during soldering) or their de-cementing.

The structure of the Herbst appliance is based on a two-sided telescopic mechanism fastened to orthodontic pivots soldered to the orthodontic bands. The bands, which anchor the appliance, are always cemented on the first mandible and upper jaw molars and first premolars [6, 13] (Fig. 2). As of late, it is the lower canines that have been used increasingly as anchors instead of the first premolars. The selection of canines as teeth of greater anchoring capacity stems from the conic shape of their anatomical crowns (as opposed to the cylindrical shape of the first molars). This prevents any potential packing of and damage to the gums caused by improperly fitted or cracked bands. Moreover, thanks to its location in the bone trajectory, the canine tends to be more stable than the molar and its forward position on the dental arch facilitates telescope extension. Thus, the patient will be provided with slightly more room for lateral mandible movement, while also being able to open their mouth slightly wider. The placement of the orthodontic bands on the canines also prohibits further intrusion of the first mandible premolars which, together with the second premolars and molars are already affected by the intrusion resulting from the bi-level occlusion plain, typical of skeletal class II.

Placed as described above the bands are then connected with a circular steel section arch 1 mm in diameter, soldered on the palatal side of the upper arch, and on the side adjacent to the tongue with the lower arch. The anchoring is more substantial when the bands are also connected on the sides adjacent to the cheeks, in both the upper and lower dental arch. This type of anchoring ought to be V-shaped, thus gaining flexibility and limiting the risk of arch fracture. Before fitting the appliance, the upper incisors should first be properly prepared. This means that skeletal class II, group 2 will require the protrusion of the upper incisors in order to gain space suitable for the protrusion of the mandible and achievement of canine class I.



**Fig. 2.** Components of the Herbst appliance

**Ryc. 2.** Elementy składowe aparatu Herbst

The upper incisors ought to be aligned so as to slightly overbite the lower incisors.

The advantages of the Herbst appliance include the following:

- continuous, round-the-clock impact of the appliance on the mastication apparatus,
- patients are no longer required to cooperate throughout their therapy,
- short orthodontic treatment period (6–8 months on average),
- elimination of permanent teeth extraction,
- rapid improvement of the patient's profile,
- quick correction of mandible position,
- recognition of appliance efficiency.

## Case Reports

The paper presents two case studies involving patients treated at the Specialist Dental Clinic NORDENT in Poznań, Poland. Their respective documentation includes: extra- and intraoral clinical examination, diagnostic model analyses, cephalometric analyses conducted prior to and following the Herbst appliance treatment, as well as photographs of the patients' faces *en face* and in profile.

### Case 1

An 18-year-old patient reported to the orthodontic clinic following an attempt to treat malocclusion using a segment alignment ribbon arch appliance supported by a removable appliance. The

lack of expected effects convinced the patient to begin an alternative form of treatment. A therapy using permanent ribbon arch appliances was suggested for the patient's upper and lower dental arch, as well as the Herbst appliance treatment to address the patient's skeletal class II malocclusion. In the course of extraoral clinical examination, a balanced, extended profile was diagnosed with a considerably deeper chin groove.

The following was established in the course of intraoral clinical examination:

- 1) misaligned upper dental arch with crowded incisors,
- 2) diastemas in the lower arch, rotated lower canines, inclined lower incisors,
- 3) angle class II,
- 4) increased overjet and overbite,
- 5) satisfactory periodontium condition.

The following was established in the course of cephalometric analysis according to Williams:

- 1) increased upper incisors inclination angle = 118.10 degrees,
- 2) increased lower incisors inclination angle = 109.43 degrees,
- 3) WITS = 7.01 mm,
- 4) intermaxillary angle = 19.88 degrees,
- 5) anteriorization – beta angle = 22.89 degrees,
- 6) overjet = 6.91 mm,
- 7) overbite = 4.70 mm,
- 8) SNB angle = 75.82 degrees.

The new treatment plan assumed the removal of the existing ribbon arch appliance, bracket sandblasting and their reattachment in order to align



**Fig. 3.** Patient's photographs before orthodontic treatment based on a new therapy plan

**Ryc. 3.** Fotografie pacjenta przed leczeniem ortodontycznym opartym na nowym planie leczenia

the upper dental arch, as well as the alignment of the inclined lower incisor and de-rotation of lower canines along with the closure of the diastemas using a ribbon arch and Herbst appliances.

The following was established in the course of cephalometric analysis following the removal of the Herbst appliance according to Williams:

- 1) upper incisors inclination angle = 112 degrees,
- 2) lower incisors inclination angle = 99 degrees,
- 3) overjet and overbite in accordance with the standards, respectively 4 mm and 3.5 mm,
- 4) WITS = 2 mm,
- 5) SNB angle = 77.98 degrees.

The Herbst appliance corrected skeletal class II, attaining skeletal class I and teeth class I, respectively. The ribbon arch appliance properly aligned

the teeth in the dental arches. The Herbst appliance treatment period amounted to 8 months.

Figure 3 presents the patient's photograph prior to orthodontic therapy based on a new treatment plan. Figure 4 presents the photograph of patient diagnostic models prior to orthodontic therapy based on a new treatment plan. Figure 5 presents an intraoral image of the patient with the Herbst appliance. Teleradiographic images were taken both before (Fig. 6a) and after treatment (Fig. 6b). The final figure presents the extraoral image following the removal of the Herbst appliance.

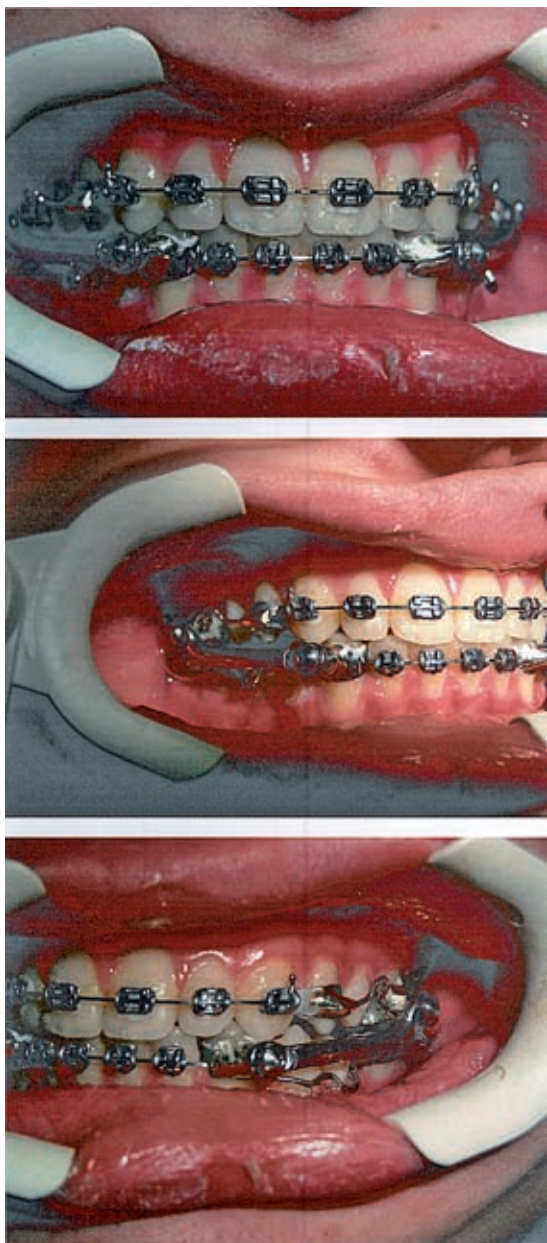
## Case 2

A 26-year-old patient reported to the orthodontic clinic to amend her facial aesthetics and



**Fig. 4.** Photograph of patient diagnostic models before orthodontic treatment based on a new therapy plan

**Ryc. 4.** Fotografia modeli diagnostycznych pacjenta przed leczeniem ortodontycznym opartym na nowym planie leczenia



**Fig. 5.** Patient's intraoral photograph with the Herbst appliance

**Ryc. 5.** Zdjęcie pacjenta wewnątrzustne z aparatem Herbsta

mastication apparatus functions (difficulties with biting off, speech impediments – lisp). In the course of extraoral clinical examination, extended profile was diagnosed with a subnasal protrusion and considerably deeper chin groove; labial stoma parted, upper incisors biting over the lower lip.

The following was established in the course of intraoral examination:

- 1) angle class II,
- 2) substantially excessive overjet,
- 3) reduced overbite,
- 4) significant upper incisors inclination angle,
- 5) upper and lower dental arch stenosis,
- 6) proper periodontium condition.



**Fig. 6.** Teleradiographic images before treatment (a) and after removal of the Herbst appliance (b)

**Ryc. 6.** Zdjęcia teleradiograficzne przed leczeniem (a) i po zdjęciu aparatu Herbata (b)

The patient's images prior to and following the treatment are presented in Figures 8, 9, 10, as well as 11a and b, while Figure 12 presents teleradiographic images before treatment (12a) and after removal of the Herbst appliance (12b).

The following was established in the course of diagnostic model analysis:

- width measurements according to Pont SI =  $6.5 + 8 + 8 + 6.5 = 29$  mm;  $P = (29 \cdot 100) / 80 = 36.5$  mm,
- patient's anterior width  $P = 32$  mm,



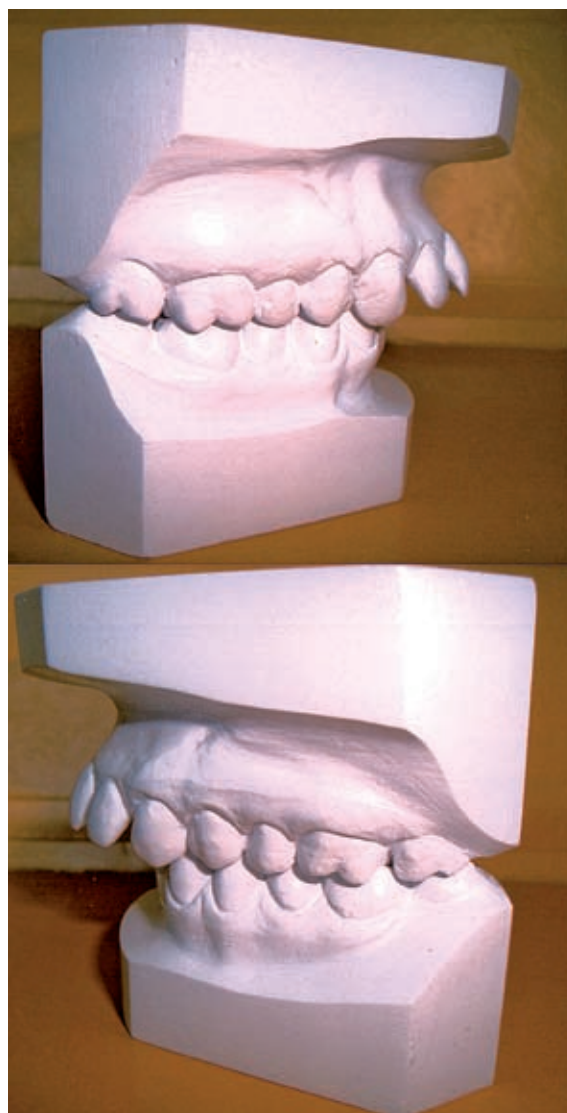
**Fig. 7.** Patient's extraoral photograph after removal of the Herbst appliance

**Ryc. 7.** Fotografia zewnętrzna po zdjęciu aparatu Herbst

- anterior stenosis of dental arches = -4.5 mm,
- patient's posterior width = 43.5 mm,
- according to the indicator  $T = (29 \cdot 100) / 64 = 45.31$  mm,
- posterior stenosis of dental arches = -1.81 mm.

The following was established in the course of cephalometric analysis:

- significant increase in the upper incisors inclination angle =  $127.63^\circ$ ,
- WITS = 9.18 mm,
- Decreased intermaxillary angle,



**Fig. 8.** Patient's plaster models before orthodontic treatment

**Ryc. 8.** Modele gipsowe pacjentki przed leczeniem ortodontycznym

- anteriorization,
- Overjet = 15.74 mm,
- Overbite = -5.76 mm,
- Considerably reduced lower incisors APg distance - 5.12 mm.

Three-stage treatment has been planned, including the following:

- preparation of the upper dental arch for frontal mandibular mobilization using a permanent ribbon arch appliance,
- fitting of the Herbst appliance,
- fitting of a permanent ribbon arch appliance following the removal of the Herbst appliance.

The duration of therapy using the Herbst appliance amounted to 7 months. As a result, a substantial improvement of the patient's profile was observed along with the smoothing of the chin



**Fig. 9.** Patient's plaster models in occlusion before and after therapy

**Ryc. 9.** Modele gipsowe pacjentki w zwarcu przed leczeniem i po nim



**Fig. 10.** Patient's plaster models – shape of dental arches before and after therapy

**Ryc. 10.** Modele gipsowe pacjentki – kształt łuków zębowych przed leczeniem i po nim

groove and the attainment of Angle class I with the canines. Angle class I for the first molars was achieved after fitting a ribbon arch appliance on the lower dental arch, which was aimed to align them and fitted following the removal of the Herbst ap-

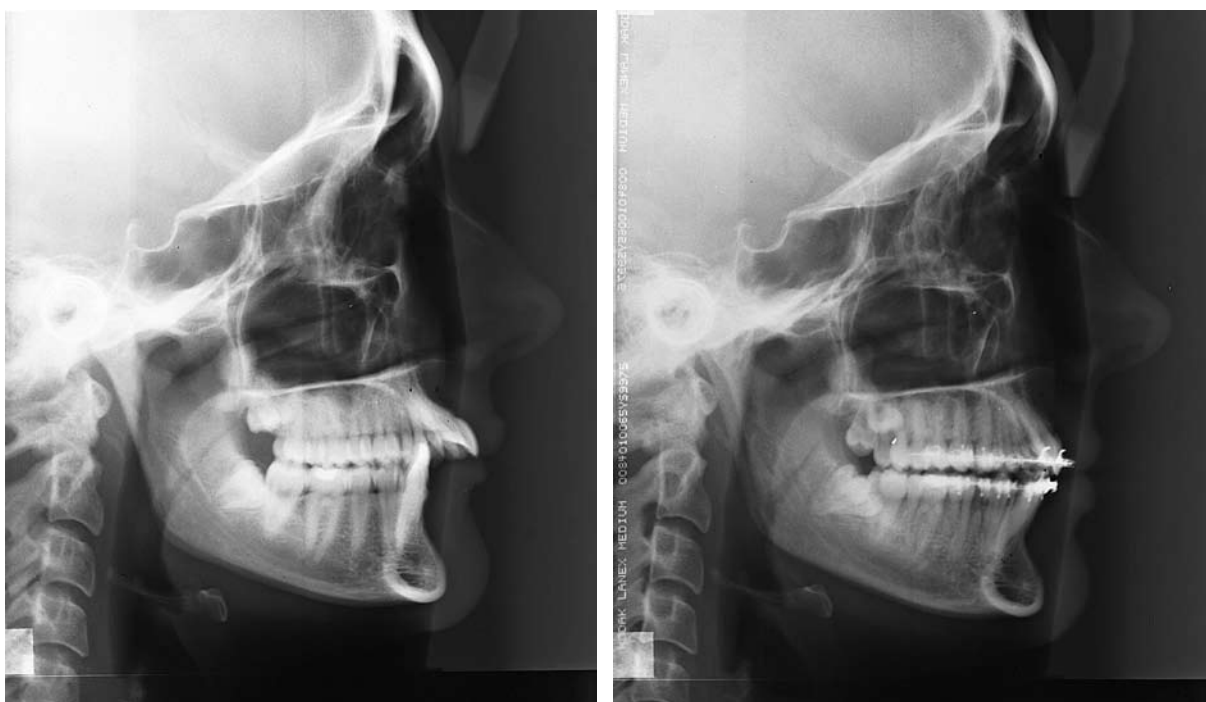
pliance. A significant improvement in the patient's profile was also obtained (Fig. 12b). The state of the patient's dentition is illustrated in figure 13.

Diagnostic model analysis following the Herbst appliance treatment:



**Fig. 11.** Patient's profile images: before treatment (a) and after removal of the Herbst appliance (b)

**Ryc. 11.** Zdjęcia profilu pacjentki: przed leczeniem (a) i po zdjęciu aparatu Herbst (b)



**Fig. 12.** Teleradiographic images: before treatment (a) and after removal of the Herbst appliance (b)

**Ryc. 12.** Zdjęcia teleradiograficzne: przed leczeniem (a) i po zdjęciu aparatu Herbst (b)



**Fig. 13.** Intraoral images after removal of the Herbst appliance (b)

**Ryc. 13.** Zdjęcia wewnątrzustne po zdjęciu aparatu Herbst

- anterior width P = 37.5 mm (excess of 1 mm),
- posterior width T = 49.5 mm (excess of 0.19 mm).

Cephalometric analysis following the Herbst appliance treatment:

- upper incisors inclination angle = 108.91°,
- WITS = 2 mm,
- overjet = 4.11 mm,
- overbite = 2.20 mm,
- lower incisors APg distance = 0.40 mm.

As one of the alternatives of orthodontic treat-

ment of patients with skeletal class II malocclusion, the Herbst appliance provides an efficient method of improving the occlusion conditions in adults. The observation of their treatment, combined with several years of clinical observations, allowed the authors to consider this method to be useful, as proven by the immediate and lasting aesthetic results stemming from the restructuring of some elements of the masticatory organ, as well as the high level of patient satisfaction following several months of treatment.

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## Address for correspondence:

Ryszard Koczorowski  
 Department of Gerodontology  
 Poznan University of Medical Sciences  
 Bukowska 70  
 60-812 Poznań  
 Poland  
 Tel.: +48 61 854 70 50  
 e-mail: rkoczor@ump.edu.pl

Conflict of interest: None declared

Received: 21.01.2014

Revised: 11.03.2014

Accepted: 6.04.2014

Praca wpłynęła do Redakcji: 21.01.2014 r.

Po recenzji: 11.03.2014 r.

Zaakceptowano do druku: 6.04.2014 r.