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**TO ASSESS THE STABILITY OF ORTHODONTIC  
TREATMENT USING PAR INDEX**

**An outline of Ph.D. thesis in Dentistry**

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This dissertation work was done to obtain the Ph.D. degree at the Department of Dentistry, Faculty of Medicine in Hradec Králové, Charles University in Prague, Czech Republic.

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## **Souhrn**

**ÚVOD:** Po ukončení ortodontické terapie je nezbytné zhodnotit stabilitu okluze jako znak dlouhodobé úspěšnosti terapie, což zároveň může ošetřujícímu lékaři posloužit jako měřítko kvality jeho práce. Tyto výsledky terapie mohou být hodnoceny různými indexy, mezi nimiž za nejspolehlivější a nejnovější vyšetření považujeme PAR index.

**CÍL:** Studie byla zaměřena na stanovení úspěšnosti ortodontické terapie pomocí PAR indexu.

**METODIKA:** Sledovaný soubor se skládal z 69 pacientů, kteří splňovali podmínky pro zařazení do této studie. Pomocí PAR indexu byly hodnoceny ortodontické studijní modely pacientů, a to před započatím léčby, bez prostředně po ní a za dva roky po jejím ukončení. Výsledky byly hodnoceny pomocí nomogramů.

**VÝSLEDKY:** Většina pacientů nevykazovala během sledovaného období po ukončení léčby žádné výraznější změny.

**ZÁVĚR:** Stav okluze u většiny pacientů nevykazoval během dvou let po ukončení terapie žádné výraznější změny. Ortodontická léčba tedy byla ve sledovaném časovém období zcela stabilní. Bylo by vhodné ve studii pokračovat a sledovat výsledky ortodontického ošetření v daném souboru i v dalších letech, již bez užití retenčních zařízení.

## **Summary**

After achieving the correction of the malocclusion, it is necessary to assess the post treatment results as it helps in assessing the stability of the treatment and it can be a self- teaching device to the clinician to assess the quality of the work. These post treatment results can be assessed using the indices. Several indices are developed over the years however the PAR index is a more recent and a reliable index.

**OBJECTIVE:** The aim of our work was to assess the stability of orthodontic treatment using PAR index.

**METHODS:** Approximately 69 patients, who met all the required criteria for the study were selected for this study. The casts of these patients were assessed before treatment, after treatment and 2 years after post treatment using PAR index and a series of scores were obtained. They were then plotted on the nomogram to assess the stability.

**RESULTS:** Most of the patients exhibited no significant variation during the post treatment phase of more than 2 years and that it was stable.

**CONCLUSION:** It can be concluded that the majority of the patients were treated to a good standard and that the results were stable. However, it is advisable to further carry out the study in order to detect the persistence of stability after few more years of treatment without the presence of retention appliances.

## **Introduction**

Assessing the stability after orthodontic treatment is a subject of interest as it helps to evaluate the post treatment results and thereby the quality of the work. Evaluating these post treatment results and assessing the orthodontically treated long-term post treatment results has been a topic of interest from several decades (14).

Stability after orthodontic treatment is essential for maintaining function and esthetics of an individual. However it is known that a large variability in orthodontic treatment outcome exists for different individuals. The variabilities could be a result of various factors like treatment approach, co -operation of patient, growth and adaptability of the hard and soft tissues. Many additional factors are known to influence stability after orthodontic treatment. These additional factors include the type, duration and the timing of the retention appliance (16). Also, many studies have been found that have described the long-term stability of specific type of malocclusions (7, 14, 15). Few other studies showed the stability of orthodontic treatment outcome longitudinally for specific occlusal traits such as open bite, overjet, overbite, cross bite, intercanine and intermolar distance and lower anterior crowding (5). Thus a lot of factors are to be taken into account to establish stability after orthodontic treatment and in order to maintain and improve the stability after establishing the results, it is advisable to assess the stability after treatment.

Studies have shown that the comparison of pre-treatment, immediate post treatment and post treatment after few years can be done to assess the stability. The study casts of pre treatment, immediate post treatment and post treatment after few years can be used for this purpose and it can be assessed to improve the quality of future treatments (11,12) and occlusal indices have been developed to assess treatment standards and to determine the success of the treatment (4, 8, 10, 11). While using an ideal index, the scores are applied to the dental and the occlusal features of a certain malocclusion and the sum of these scores ranks the malocclusion, to which a weighting is then added. The selection of weightings adds subjectivity to the index and balances the impact of the individual components of the overall result.

In order to overcome the difficulties created by using indices inappropriately, two indices were developed. One to measure the orthodontic treatment need called the Index of treatment need (IOTN) and the other to assess the standard of treatment called the Peer Assessment Rating index (PAR). Richmond introduced a new method for measuring treatment standards, the Peer Assessment Rating (PAR) Index. In recent years PAR index was developed to record malocclusion in the mixed and permanent dentition. The index was formulated over a series of six meetings in 1987 with a group of 10 experienced orthodontists. The index is rather simple, objective and a reliable manner (20) for evaluating the stability after orthodontic treatment. Several studies have been conducted to assess the stability after orthodontic treatment using the PAR index (1, 2, 9, 13, 18, 21, 22).

The aim of the present study was to evaluate the overall quality of orthodontic treatment 2 years post treatment in a sample of patients in the Division of Orthodontics, Department of Dentistry, Faculty of Medicine in Hradec Králové.

## **Aim of the study**

The aim of the study is to assess the stability after orthodontic treatment after 2 years of post treatment using PAR index in the Division of Orthodontics, Department of Dentistry, Teaching Hospital in Hradec Králové.

The evaluation of results is normally done to estimate the nature and quality of work, so that justice can be done to the work that we do and also that the patients will be satisfied which inturn can lead to increase in self confidence of the patient. As the primary motive of every orthodontist should be to treat the patient effectively and successfully with long lasting results.



## **Material and methods**

### **Type of study**

The study was mainly retrospective in nature as the study required the study casts for the measurements of the occlusal traits before treatment, after immediate treatment and during the 2 years post treatment phase.

### **Required criteria for the study**

During the selection of the sample for the study, the following criteria were considered:

1. The patient's co-operation and consent was necessary and after which the impressions were made in the post treatment phase.
2. The patients were required to belong to the group of more than or equal to 2 years of post treatment phase.
3. The sample of the study casts collected involved group of patients, who were treated by fixed appliances or by a combination of removable and fixed appliances.
4. Further the study consisted of study casts, where treatment was done in both dental arches.
5. The study casts were considered to be intact without any broken margins.

### **Sample**

Initially, the sample of patients were needed to be selected for assessing the stability after 2 or more years of orthodontic treatment from the Division of Orthodontics, Department of Dentistry in Hradec Králové. The study was done using the PAR index. Approximately 90 patients were invited for the study, out of which 73 patients reported and agreed for the study. After completion of more than 2 years of orthodontic treatment, the decision was made for the impression of patients. The patients were between the age groups of 15-29 years.

The male to female ratio was 18:55, indicating that a large number of patients were females, who received orthodontic treatment. The average year of completion of orthodontic treatment in these patients was more than two years as the treatment was completed in 2004 and they were in the period of retention after treatment during the year 2006.

Further, the study got limited to 69 patients. This was because only 69 patients met all the required criteria for carrying out the study.

## **Materials used for the study**

The materials that were used for the study of assessing the stability after orthodontic treatment using PAR index were:

- a. Pre treatment, immediate post treatment and more than 2 years post treatment study casts.
- b. The PAR index ruler
- c. A pair of straight compasses.

## **Methods**

The method was to assess this group of 69 patients using PAR index for evaluating the study after 2 years or more of post treatment phase.

Accordingly, the study casts of the pre treatment, immediate and more than 2 years of post treatment were evaluated using the PAR index as this index has been reliable due to the reason being that many studies were carried out over the years and it is established that the PAR index is one of the valid and reproducible index. The index is known to contain a scoring system for each component of the dentition, i.e. the alignment in the anterior segment, the buccal segment relationship on both sides of the dentition, the overjet, the overbite and the centerline discrepancies. Each score is known to depict the condition of the dentition. For example: A score of zero indicates a good alignment, while higher score indicates a higher irregularity of the dentition. Further according to the index, the difference between the score at the beginning and at the end of the treatment showed the degree of the improvement and the success of the orthodontic procedure.

The index contains a ruler that is a short summary of the index and acts as a tool for scoring the conditions in the malocclusion. Thus the 69 study casts of pre treatment, immediate post treatment and the post treatment phase of more than 2 years were evaluated using the PAR ruler by one clinician. The evaluation was done twice by the same clinician to reduce the risk of errors, if any and the interval between the measurements was 6 weeks.

According to the rules of the PAR index, each of the components of the dentition i.e. anterior segment (upper and lower), buccal segment relationships on both sides, overjet, overbite and midline discrepancies could be scored. Thus the scores were needed to be applied to the study casts of three different phases for each patient. Accordingly the scores were applied to the pre treatment, immediate post treatment and 2 years after post treatment

and a series of scores were obtained. *Table No. 1* shows examples of 4 cases with scores that were applied to each of the components of the pre treatment study casts using the PAR index.

Patients	Upper anterior segment	Lower anterior segment	Right buccal occlusion	Left buccal occlusion	Overjet	Overbite	Centreline
1.	4	2	0	0	1	0	1
2.	5	2	2	3	1	2	2
3.	4	1	3	3	1	1	2
4.	1	1	2	2	1	0	0

***Table No. 1 Scores for each components of the dentition of pre treatment casts obtained on applying the PAR index***

The individual scores are then multiplied by the weightings derived for the five components of the PAR index. For example: The upper and the lower anterior segments were multiplied by 1, right and left buccal occlusion by 1, overjet with 6, overbite with 2 and centerline with 4 and is shown in *Table No.2*. This is done because of the fact that the PAR index components are weighted to balance the impact of the individual components of the overall result.

Patients	Upper anterior segment	Lower anterior segment	Right buccal occlusion	Left buccal occlusion	Overjet	Overbite	Centreline
1.	4 x 1	2 x 1	0 x 1	0 x 1	1 x 6	0 x 2	1 x 4
2.	5 x 1	2 x 1	2x 1	3 x 1	1 x 6	2 x 2	2 x 4
3.	4 x 1	1 x 1	3 x 1	3 x 1	1 x 6	1 x 2	2 x 4
4.	1 x 1	1 x 1	2 x 1	2 x 1	1 x 6	0 x 2	0 x 4

***Table No. 2 Scores with their respective weightings for all the 69 patients that are assessed before treatment***

Upon multiplying the individual scores with the respective weightings, they are summed to establish the overall total as shown by *Table No. 3*.

Patients	Overall total
1.	16
2.	30
3.	27
4.	14

***Table No. 3 Scores with their overall total that is obtained by adding each of the components that were multiplied with its respective weightings***

Similarly the measurements were obtained for each component of the post treatment and the 2 years post treatment study casts. They were also multiplied with their respective weightings to balance the impact of the individual components of the overall result. Thus after applying the PAR scores to the three phases of the study, the pre treatment weighting PAR score, post treatment weighting PAR score and the 2 years post treatment weighting PAR score were obtained. It can be represented by *Table No. 4* as follows:

Patients	Pre treatment PAR weighting score	Post treatment PAR weighting score	2 years Post treatment weighting score
1.	16	0	3
2.	30	2	5
3.	27	7	9
4.	14	2	4

***Table No. 4 Total weightings in three phases of treatment***

After obtaining the scores for each of the three phases of the study, they are needed to be evaluated for assessing the improvement or deterioration of the results. This can be done with the help of the nomogram.

## Results

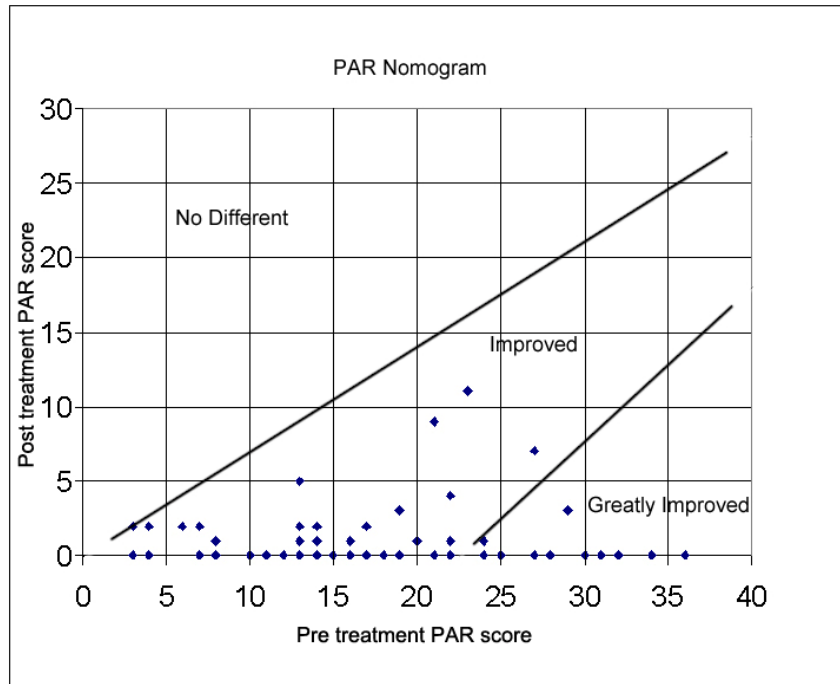
The scores obtained were subjected for assessment using the nomogram. The nomogram is one of the possible ways of assessing the improvement or the deterioration of the treatment and thereby helps in assessing the stability and quality of work.

In the study of assessing the improvement with the help of nomogram, the pre treatment weighted PAR score was given on the horizontal x axis and the post treatment weighted PAR score on the vertical y axis. The pre treatment and the post treatment scores were read on their respective axis and where the intercept falls, it indicates the degree of improvement which helps to provide three broad bands of treatment change, ie

- a. Worse, no different
- b. Improved
- c. Greatly improved

Firstly, the nomogram was plotted with the total PAR weightings of pre treatment on x axis with the scores starting from 0 to 40 with a difference of 5 between each reading, similarly the total PAR weightings of post treatment were plotted on y axis with the scores starting from 0 to 30 with a difference of 5 between each reading. The following is represented with the *Graph No. 1* as shown below.

Graph No. 1 helps in detection of improvement of the cases, i.e. it helps to know if the treatment was worse without any significant improvement, which could be referred to as Worse- no different, or if there was a significant improvement, which could be referred to as Improved, or if there was a marked improvement, which could be referred as Greatly improved, thus in this way the treatment results can be assessed using the below nomogram.

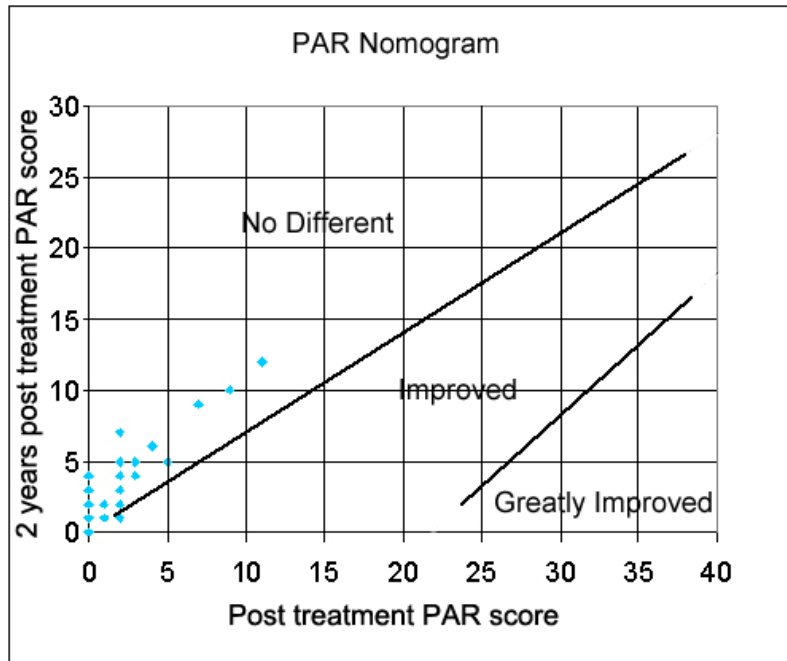


**Graph No. 1** Pre treatment PAR score on the x axis and the Post treatment PAR score on the y axis

The above nomogram was obtained by placing the overall total of the patients that were obtained before and after treatment during the study. Thus we can see from the nomogram that

1. No patients fell into the category of **No Different** band of treatment change.
2. A large group of patients are in the range of 0 to 22 points, indicating that the cases fell into the category of **Improved** band of treatment change.
3. A fewer group of patients fell into the range of PAR score greater than 22 points, indicating that the cases fell into the category of **Greatly improved** band of treatment change.

Secondly the nomogram was plotted with the total PAR weightings after treatment on x axis and post treatment of more than 2 years on y axis starting from 0 with a difference of 5 points on each axis as shown in *Graph No. 2*.



**Graph No. 2** Post treatment PAR score on the x axis and 2 years post treatment PAR score on the y axis

The above nomogram was obtained by placing the overall total of the patients that were obtained after and during 2 years of post treatment phase of the study. Thus we can see from the nomogram that

1. Most of the patients fell into the first category of treatment change, indicating that the cases showed no significant variation during the post treatment phase of more than 2 years.
2. On the other hand, one point was evident in the second category of the change in treatment, indicating that the case was slightly deviating from the achieved result.
3. No patients fell into the third range of the treatment change, indicating that no case exhibited such a great deviation after treatment.

## **Discussion**

The availability of a definition for normal occlusion (3) set a standard for comparison of treatment outcomes. The six keys of occlusion that contribute to normal occlusion were introduced by Andrews during the 1970's. According to Andrews, the presence of these features were essential to achieve an optimal occlusion. The six keys to normal occlusion are molar interarch relationship, mesio distal crown angulation, labio lingual crown inclination, absence of rotation, tight contacts and curve of Spee. Thus in order to detect the clear definition of what constitutes a deviation from normal occlusion, it became necessary to increase the subjectivity of assessing results.

Besides this the grading of orthodontic treatment results at study group meetings has been practised for many years. The concept of individuals grading their own treatment results can be a self-teaching device and may improve the quality of future treatment. In the field of research the need for accurate measure is even more critical.

One of the possible ways to assess the treatment results and to compare it with the normal occlusion is by the way of assessing it with the indices. Several orthodontic indices have been developed to assess the treatment need and outcome. But many of the indices have their own limitations, due to which the use of an index with fewer limitations becomes a necessity as the basic requirement for use of an index is that it should be valid and reliable and easy to use and to amend for modification. Although over the years, the strength and limitations of the various indices were well documented, one of the index that is known to satisfy all the required objectives is the PAR index.

PAR index was developed by Richmond et al. It measures occlusal characteristics and has been used for assessment over the years after its introduction into the field of orthodontics. The PAR index is a weighted combination of seven occlusal traits, upper and lower anterior alignment, right and left buccal occlusion, overjet, overbite and centreline. Later the weightings for the separate components were derived from the validation studies that were done due to the panel assessment study. The experience of the PAR index is still at an early stage, although several practical uses are described that the PAR index has an excellent validity and has been demonstrated and also been tested in a series of investigations. Intra examiner reliability was also excellent (6, 17, 19, 21). Thus finally according to the study of Richmond et al., it was said that it was possible to teach staff without dental qualification or training to use the weighted PAR index to a high level of reliability.



The PAR index was used for the study of assessing the orthodontic treatment before treatment, immediate after treatment and during post treatment phase of more than 2 years in the Division of Orthodontics, Department of Dentistry in Hradec Králové. In this study, no attempt was made to compare treatment results by different types of appliances, but the study was mainly involved in a group of patients who were invited for the study and upon the consent of the patients and their parents, the study was started and it included patients with fixed appliance therapy or a combination of fixed and removable appliance therapy and the majority of the patients were females due to the fact that the ratio of male to female was 18:55 at the onset of the treatment, which gradually reduced to the ratio of 17:52, the reason being the inavailability of the criteria that was essential for the study. On assessing the study casts during each phase of the study, a set of scores were obtained that were then multiplied with their respective weightings and then the overall total was obtained. It was then plotted on the nomogram and assessed for the results.

Further it was found that a large number of patients fell into the category of *Improved* and *Greatly Improved* range of improvement, which showed that the majority of the cases were treated to a very good level. Also when the post treatment and the post treatment phase of more than 2 years were compared, majority of the patients fell into the group of *No different* category of treatment indicating that the treatment results were stable and that it didnt exhibit significant variations. For an institution as well as for a private practise such an analysis can contribute to quality assurance of treatment outcome over the years. The assessment also acts as an important tool in the process of total quality management of orthodontic care provision.

In this study, the improvement in PAR score at the post treatment stages can be explained to some extent by the treatment period, more recent the period the better quality was obtained in the results. Although it is known that the occlusal deterioration occurs in the period that follows orthodontic treatment, the dual arch fixed appliance treatment achieves and maintains the best post-treatment results. Also the stability of the results can be due to the fact that the patients were still in the retention phase of the treatment. Thus the PAR index helped in evaluating the study casts. It is known to offer uniformity, objectivity and standardization in assessing the outcome of orthodontic treatment.

However, it needs to be revised in the light of new knowledge and the changing perceptions of standards and mainly to overcome the limitations that exist with the index as the PAR index exhibits certain obvious limitations that must be considered when it is used in the evaluation of treatment outcomes. For example, it cannot identify inappropriate arch expansion, inclination of incisors and cannot measure improvements in appearance or psychosocial well being.

## Conclusions

In this study, the relapse pattern was comparable for a group of patients in the Division of Orthodontics, Department of Dentistry, Teaching Hospital in Hradec Králové. The following was obtained as a result of the study:

1. When the study was made between the pre treatment and the post treatment phases, a majority of the patients of the group fell into the *Improved* or the *Greatly improved* range, indicating that the cases were treated to a good standard.
2. On the other hand, when the study was compared for the stability of the result after more than 2 years of post treatment phase, it showed that the cases fell into the range of *No different* category indicating the cases appeared to be stable to a large extent.

As a conclusion, it is possible to conclude that the majority of the patients were treated to a good standard and that the results appeared to be stable. However this can be supported by saying that the patients were in the retentive phase after treatment that helped in maintaining the results obtained.

It is advisable to further carry out the study in order to detect the persistence of stability after few more years of treatment without the presence of retention appliance. Also more research in the field of indices becomes essential with time to provide the comparison of the results.

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- Ramanathan C, Hofman Z: **Orthodontic treatment of frontal and lateral cross bite.** Abstract book of 3<sup>rd</sup> World Edgewise Orthodontic Congress and 40<sup>th</sup> Indian Orthodontic Conference, Nov 2005, Chandigarh, India.
- Ramanathan C, Hofman Z: **Orthodontic treatment of frontal and lateral cross bite.** Abstract book of Sazamovy dny 2005, Hradec Králové, Czech Republic.
- Ramanathan C, Hofman Z: **Orthodontic treatment improves self confidence.** Abstract book of 11<sup>th</sup> Annual Meeting of the European Association of Dental Public Health, Sept 2006, Prague, Czech Republic.
- Ramanathan C; Hofman Z: **Class II malocclusion treatment with Sabbagh Universal spring.** Abstract book of 7<sup>th</sup> Congress of the Czech Orthodontic Society Annual, Sept 2006, Prague, Czech Republic.

#### **Presentations and posters**

- Ramanathan C: **Role of orthodontics in the present dental medicine.** Clinical Seminar at the Department of Dentistry, Jan 2006, Hradec Králové.
- Ramanathan C, Havel P, Hofman Z: **Co-operation between orthodontists and paedodontists.** Clinical Seminar at the Department of Dentistry, April 2006, Hradec Králové.
- Ramanathan C.: **Stability after orthodontic treatment using PAR index.** Clinical Seminar at the Department of Dentistry, June 2006, Hradec Králové.
- Ramanathan C, Hofman Z: **Orthodontic treatment of frontal and lateral cross bite.** International 3<sup>rd</sup> World Edgewise Orthodontic Congress and 40<sup>th</sup> Indian Orthodontic Conference, Nov 2005, Chandigarh, India.
- Ramanathan C, Hofman Z: **Orthodontic treatment of frontal and lateral cross bite.** Sazamovy dny, 2005, Hradec Králové.
- Ramanathan C; Hofman Z: **Orthodontic treatment improves self confidence.** 11<sup>th</sup> Annual Meeting of the European Association of Dental Public Health, Sept 2006, Prague.
- Ramanathan C, Hofman Z: **Class II malocclusion treatment with Sabbagh universal spring.** 7<sup>th</sup> Congress of the Czech Orthodontic Society Annual, September 2006, Prague.