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To assess the stability of orthodontic treatment

using PAR index

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

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SECTION II: EXPERIMENTAL PART

1. 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 (26).

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 (29). Also, many studies have been found that have described the long-term stability of specific type of malocclusions (12, 26, 27). 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 (7). 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 (18, 20) and occlusal indices have been developed to assess treatment standards and to determine the success of the treatment (5,13, 15,18). 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 (37) 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, 14, 23, 32, 43, 44).

The aim of the present study is to evaluate the overall quality of orthodontic treatment 2 years post treatment in a collected sample of patients in the department of orthodontics, Faculty of medicine in Hradec Králové.

SECTION I: THEORETICAL PART

1. STABILITY AFTER ORTHODONTIC TREATMENT

Stability refers to a state, which does not change but instead remains constant in nature. Long- term post treatment stability is an issue of great concern to all orthodontists, as stability at the end of the result is one of prime objectives of orthodontic treatment, for without stability neither proper function nor esthetics can be maintained.

Stability acts as a good criterion, which is known to help in judging a successfully treated case. However the reality is found to be different that the treated cases relapse after a certain period of time. A question that often is raised regarding long- term stability results after orthodontic treatment is which length of period should give an appropriate estimate of stability. From the cost effectiveness point of view, a lifelong lasting effect of orthodontic therapy would be the preferred consequence. In some studies (5), it has been stated that expecting a high degree of stability after 20 years exceeds the usual expectations in the other fields of medicine and dentistry, other long term changes of the dentition due to growing, aging, periodontal diseases and caries as well as various types of dental restorations should be considered. Also studies have shown that an evaluation period of 10 years does justice to the nature of orthodontics.

Although permanent retention is an option of achieving long-term stability, but as trained orthodontists it becomes duty to deal with the factors associated with the relapse and to aim in removing the relapse factors. These factors are to be taken into consideration and the retention phase of the patient should be planned so that the post treatment changes can be overcome to a large extent. The retention phase is defined as that phase of orthodontic treatment, which eliminates the factors causing relapse. It is defined by Moyers as "maintaining newly moved teeth in position long enough to aid in stabilizing their correction". The retention of teeth in ideal functional and esthetic position has always been a challenge to the orthodontist.

1.1. Factors affecting stability

Although numerous factors have been reported to play a role in loss of stability, no definite conclusions regarding the relative contribution of these factors have been reached (6, 21, 48). Some areas of investigation include:

1. Alteration of arch form

2. Periodontal and gingival tissues

3. Mandibular incisor dimensions

4. Influence of environmental factors and neuromusculature

5. Consideration of continuing growth

6. Post treatment tooth positioning and establishment of functional occlusion

7. Role of developing third molars

8. Influence of the elements of the original malocclusion

1.2. Stabilizing procedures

Stabilizing the treatment results by retention procedures is an integral part of orthodontic treatment, thus adequate retention must be planned following effective orthodontic treatment. The retention should be planned in such a way that the destabilizing factors that cause relapse are to be eliminated.

1.3. Rules to enhance stability

To enhance the stability after orthodontic treatment, the orthodontist should strike a balance in fulfilling the major esthetic desires of the patient within the bounds of keys that stand for stability. Riedel and Moyers put forth some of the postulates or theorems of retention, which when incorporated during the retention phase of the treatment helps in overcoming the relapse (9). They include:

Theorem No.1:

"Teeth that have moved tend to return to their former position".

Theorem No.2:

"Elimination of the cause of malocclusion will prevent relapse".

Theorem No.3:

"Malocclusion should be over corrected as a safety factor".

Theorem No.4:

"Proper occlusion is a potential factor in holding teeth in their corrected positions".

Theorem No.5:

"Bone and adjacent tissues must be allowed time to re organize around newly positioned teeth".

Theorem No.6:

"If the lower incisors are placed upright over basal bone they are more likely to remain in good alignment".

Theorem No.7:

"Corrections carried out during periods of growth are less likely to relapse".

Theorem No.8:

"The farther the teeth have been moved, the lesser is the risk".

Theorem No.9:

"Arch form, particularly in the mandibular arch, cannot be permanently altered by appliance therapy".

Theorem No.10:

"Many treated malocclusions require permanent retaining devices".

1.4. Types of retention used to enhance stability

Depending on the severity of malocclusion, the retention can be of three types:

1. Natural or no retention: It refers to the malocclusions that do not require retention. Example: Serial extraction procedures.

2. Limited or Short term retention: It refers to the malocclusion where the retention is required for the short period. Example: Class I non extraction cases.

3. Prolonged or permanent retention: It refers to the malocclusions that require permanent retention, without which they are going to relapse. Example: Severe rotations.

1.5. Retainers used in orthodontics

Retainers can be defined as passive orthodontic appliances that help in maintaining and stabilizing the position of the teeth. They are known to allow the repositioning of the supporting structures after the active phase of orthodontic therapy.

When we select a retainer after effective orthodontic therapy, we must consider a number of factors. They include the following:

1. Type of malocclusion treated
2. The esthetic needs
3. Patient's oral hygiene
4. Patient's co-operation
5. Duration of retention needed

1.6. Requisites for a good retainer

Certain requisites that are needed to fulfill the characteristic of a good retainer as suggested by Graber are as follows:

1. The retainer should retain all the teeth that have been moved into desired positions.

2. It should permit normal functional forces to act freely on the dentition.
3. It should be self-cleansing and should permit oral hygiene maintenance.
4. It should be as inconspicuous as possible.

1.7. Classification of retention appliances

The retainers can be classified as

1. Removable retention appliances
2. Fixed retention appliances

The removable retention appliances can be defined as the passive appliances *(Picture No. 1),* that can be removed by the patient and reinserted at will.
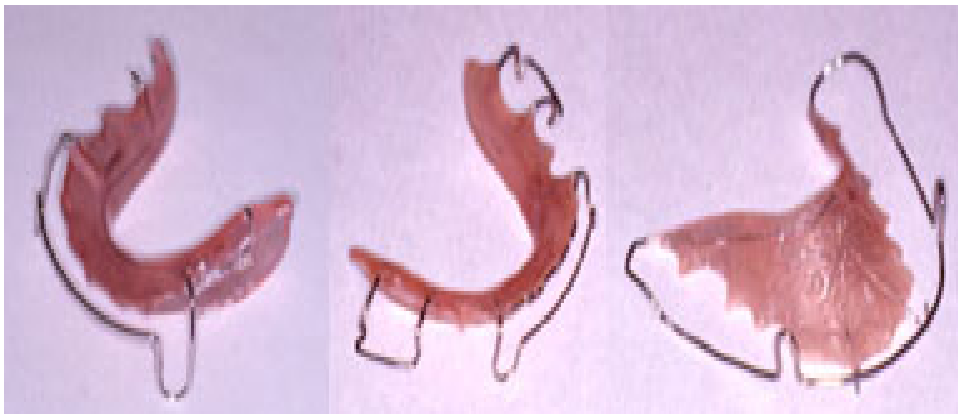
Picture No. 1: Examples of Hawley's appliance

Advantages of removable appliances:

1. It offers the ability to maintain good oral hygiene.
2. It requires less chair side time in case of problems.

Disadvantages of the removable appliances:

1. The main disadvantage is the need for patient co-operation.
2. Failure in following the instructions for the removable appliance wear results in loss of retention.

On the other hand the fixed retention appliances can be defined as the passive appliances that are fixed or fitted onto the teeth *(Picture No. 2)* and cannot be removed and reinserted by the patient, unlike the removable appliances.
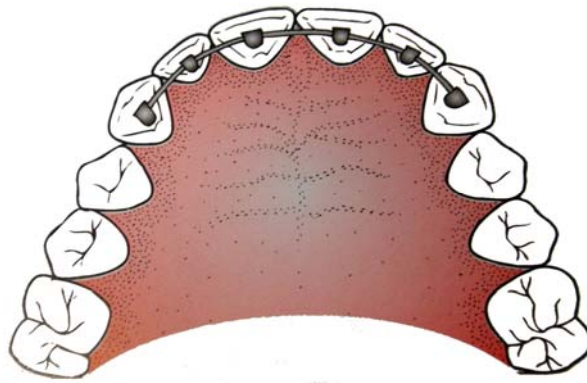
Picture No. 2: Example of fixed bonded retainer

Advantages of fixed retainer:

1. The main advantage is there is no need for patient co-operation.
2. It ensures adequate retention as the retainer is fixed in place.

1.8. Special requirements for achieving retention and stability in various malocclusions

1.8.1. Class II malocclusions:

Class II malocclusions usually occur as result of discrepancies in the growth of the jaws i.e. the differential growth of maxilla relative to mandible is known to occur. Thus to prevent the relapse in the class II malocclusions, it is necessary to consider the

growth related change and evaluate the different factors. The factors can be age, sex, maturity of the patient.

Further the minor relapses can occur during the tooth movement due to gingival and periodontal factors. If the relapse is at a larger scale, then the factor related to growth could be a reason.

However some authors recommend one of the possible ways of overcoming the relapse tendency is to prevent this differential growth of jaws using the headgear therapy to restrict the maxillary growth. It is advisable to recommend for the headgear therapy in cases where the active treatment is completed at earlier age while the continued growth is seemed to be still present after the active phase of orthodontic treatment.

1.8.2. Class III malocclusions:

In cases of class III malocclusions, the continued growth of the mandible could be a risk factor for causing the relapse. The use of delaire mask or chin cap becomes essential to modify the growth pattern, depending on the prediction of growth pattern.

1.8.3. Deep bite

Deep bite is one of the frequently seen malocclusions. It is one of the most damaging malocclusion. It is known to affect the masticatory apparatus and the dental units. It is possible to correct the deep bite either by the intrusion of incisors or by the extrusion of the molars depending on the case. One of the possibilities to prevent the relapse in dental deep bite cases is with the help of removable retention appliances. However surgery may be the choice in cases of deep bite occurring due to skeletal malrelations.

1.8.4. Open bite

Relapse of dental open bite cases occurs due to two reasons:
a. Incisor intrusion
b. Molar extrusion

The incisor intrusion could occur due to the continued indulgence in habits, for example thumb sucking, and tongue thrusting. Thus, the habits of the patients should be effectively treated to overcome relapse and thereby to maintain long term stability.

On the other hand, the excessive vertical growth tendency in a patient and the continued eruption of posteriors could also be a reason of relapse. In such cases, posterior bite plane appliances can be used so that it stretches the musculature and thereby an intrusive effect can be exerted on the dentition (9, 16, 33). However surgery may be the choice in cases of open bite occurring due to skeletal malrelations.

1.9. Necessity for assessing stability

Stability is a good criterion, which is known to help in judging a successfully treated case. Improvement in the dentition through orthodontic treatment can obviously be achieved, but there is a tendency for it to return towards the original malocclusion many years post treatment, thus to evaluate this, it is essential to evaluate stability after treatment. The necessity for assessing stability is a topic of interest as it helps to detect relapsing factors if any and the elimination of these factors becomes essential to achieve long term stability.

Clinical studies in orthodontics have shown that many cases are treated and reported consecutively, but it also includes cases that were consecutively finished (12). i.e. In spite of excluding the patients who failed to complete the treatment and whose records were not available. In order to evaluate the success of a particular treatment or of an operator, it becomes essential to assess the stability. It is seen over the years that the changes in facial profile or cephalometric parameters that reflect the skeletal component of the malocclusion are not considered in the quantitative evaluation as measurements of these variables have not been achieved by any valid and reliable method due to the following reasons:

❖ Firstly the individual biologic variations require discrimination between changes attributable to orthodontic intervention and those due to the growth and development of the facial complex.

❖ Secondly, the ideal cephalometric analysis or cephalometric goals of orthodontic treatment are controversial with no consensus throughout the profession.

❖ Finally, no universally accepted methods currently exist to assess change in facial profile as an outcome measure.

Thus for the time being, the optimal and the most feasible method for assessing the attainment of desired occlusal outcomes is by the use of occlusal indices. This procedure enables an accurate evaluation of many of the effects of treatment.

One of the possibilities in assessing the outcome of orthodontic treatment is to measure the success via the use of an occlusal index. However, trying to achieve an ideal occlusion based on the anatomy of the teeth has been described as an ideal goal but it is considered to be a therapeutic impossibility (13). Several orthodontic indices have been developed (17, 39, 46). To assess the treatment results, it is advisable to use occlusal indices like Summer's Occlusal Index, Eisman's Index, Ingerval's NT (Need of Treatment), DFA (Dento facial Attractiveness) scale, IOTN- Index (Index of orthodontic treatment need). (3, 8, 11, 15, 22, 28, 30, 31, 32, 34, 35, 36, 40, 46). These indices apply to a score to each feature of the malocclusion to which a weighting is then added. The selection of these weightings adds subjectivity to the index reducing the validity and reproducibility (19). To overcome the problem, the PAR index was developed during the recent times and it helps in assessing the orthodontic treatment and thereby evaluates the quality of the treatment (31, 35, 36, 37, 38).

2. IDEAL INDEX

2.1. Definition

A practical and relatively simple measure that might be used for orthodontic outcomes research can be defined as an *ideal index*.

2.2 Properties of an ideal index

It has been suggested that an ideal occlusal index should possess the following properties (11):

1. Reliability: The index should be able to measure consistently at different times and when used by different examiners.

2. Validity: The index should measure what it purports to measure.

3. It should be amenable to modification.

4. It must yield quantitative data.

5. It should lead itself to the rapid application by trained examiners.

One of the indices that are known to satisfy all these criteria is the Peer Assessment Rating Index. (36)

2.3. Types of indices

Studies have shown that many indices were developed over the years for the use in the field of orthodontics (17, 24, 25, 39, 46). Some of the indices that were developed one after the other are as follows:

a. Summer's occlusal index
b. Eisman's index
c. Ingerval's NT index
d. Dentofacial Attractiveness scale

e. Index of orthodontic treatment need (IOTN)
f. PAR index

All occlusal indices can be applied by the fact that they have score for each feature of the malocclusion, but the main disadvantage is the selection of weightings to the index. The selection of weightings was developed with a view to add subjectivity, however the main disadvantage was it reduced the validity and reproducibility. Thus to overcome the unwanted effects resulting from the index, more recent advancement was done to measure the features of malocclusion and the indices IOTN and PAR index were developed. It was mainly developed to measure orthodontic treatment need, while the PAR was developed to assess the standard of treatment.

➢ *IOTN index*

The index of the orthodontic treatment, need ranks malocclusion in terms of the significance of various occlusal traits upon the individual's dental health and aesthetics. The index incorporates an Aesthetic and Dental health component. The Dental health component is comprised of three main categories representing "No need", "Borderline need" and "Need" for orthodontic treatment. Each occlusal trait that may contribute to the longevity and satisfactory function of the dentition is defined and placed into a grade. In use, the features of the dentition are noted and measured. A grade is then allocated according to the severity of the worst trait. The Aesthetic component of the index is a visual scale. It is a series of numbered photographs that have been ranked for dental attractiveness by lay individuals. A rating is allocated for general attractiveness rather than specific morphological similarity to the photographs. The value selected assesses the patient's aesthetic impairment, and by inference reflects the socio psychological need for orthodontic treatment. The Aesthetic component has four main categories representing "No need", "Slight need", "Moderate need" and "Great need" for treatment (10).

➤ *The Peer Assessment Rating (PAR index)*

This index is said to evaluate dento occlusal change. Scores are allocated according to the degree of irregularity of the dentition (including impactions), buccal segment relationship, overjet, overbite and centerline discrepancy. The higher the PAR scores the greater the deviation from an ideal occlusion and the greater the change in PAR scores the greater the change in occlusion and alignment. The changes in score following treatment may be expressed as the percentage change in PAR score and by classification into groups of "worse or no different", "improved" or "greatly improved".

2.4. Application of indices

The application of indices should offer several advantages (37, 38, 41, 42, 43). It should include the following:

1. *Uniformity:* The index used for assessing the sample of patients should provide a set of guidelines that should lead to more uniformity of assessment of the need for treatment. This implies that such an index must be constantly reviewed and updated in the light of new information.

2. *Patient Counseling:* Patients should be given a chance to express their desire for treatment. It is known that the patients agree to the advice of the orthodontists if the decision is based upon broadly agreed clinical convention rather than a personal view. To depict the clinical convention, it is essential to prove the results. Thus the index should provide a method of assessment.

3. *Resource allocation and planning*: In most of the common circumstances of limited public resources that we come across like for example: health care, better treatment of fewer patients seems a better proposition otherwise a dilution of resources could occur, which inevitably leads to risks or benefit imbalances. Manpower and resource planning can be possible where cut off points are agreed and the proportion of treatment uptake can be estimated realistically.

4. ***Monitoring and Promoting standards:*** The index that is used should offer confidence and should act as an indicator of clinical performance for interested practitioner or for quality control. It should also be used to evaluate different systems of delivery of orthodontic care, and to assess the efficacy of contrasting treatment modalities.

2.5. General limitations of Indices

Although, there exists many indices for measuring the degrees of malocclusion. The indices seem to be having its limitations. Some of them are as follows:

1. The indices measure the tooth position that, although important, is not the only factor in orthodontic treatment. Factors like incisor- inclination, decalcification, root resorption, gingival recessions and functional and aesthetic considerations of the face are disregarded completely although they undoubtedly are important and known to be a contributing factor to the quality of treatment.

2. The mixed dentition is not considered, thus it leads to limited objective treatments and thereby definitive treatment is not possible.

3. Facial profile changes or cephalometric parameters that is essential in reflecting the skeletal component of the malocclusion is not considered during evaluation using indices.

4. The indices do not provide time duration for their measurements, as a result there could be a deterioration of the treatment results. For example: the results can show changes in scores that were treated and measured very early, before the completion of growth and thereby could exhibit faster deterioration of the treatment results.

5. The indices do not enable the assessing of the treatment outcome in an untreated control sample of patients.

3. INDEX MOST COMMONLY USED FOR ASSESSING STABILITY

Many indices exist, but due to their limitations, the most commonly used index for assessing the stability is the PAR index and it can be proved by many studies that were conducted to assess the stability over a period of time (14, 47, 48).

3.1. The Peer Assessment Rating Index (PAR INDEX)

The grading of orthodontic treatment results at study group meetings has been practised for several years. The concept of individuals grading their own treatment results can be a self-teaching device and could improve the quality of future treatment. In the field of research, always the need for accurate measure is more critical. The use of system is essential, that possess a quantitative objective method for measuring malocclusion and efficacy of treatment. As a result the Peer Assessment Rating (PAR index) was developed to record the dental malocclusion at any developmental stage and it fulfills the required criteria.

The PAR index (Peer Assessment Rating Index) was a British occlusal index that measured the severity of dental malocclusion and had been used in several investigations that helped in the evaluation of the effectiveness of orthodontic treatment provision in Europe. As a part of its development, the PAR index was validated for malocclusion severity, by using the opinions of a panel of 74 dentists and orthodontists. The investigation was also carried out by an American panel of 11 orthodontists and the findings resulted to derive a set of weighting factors for the PAR index and to calculate scores that would represent groupings of malocclusions severity. Thus in this way PAR index was considered to represent a good approximation of malocclusion severity and can be used as an outcome measure for the assessment of dento-occlusal change and thereby helps in assessing the effectiveness of orthodontic treatment (11).

3.2. Segments used for assessment of PAR index:

The PAR index satisfies the criteria of an ideal occlusal index and it is used to measure occlusal change of the dentition. The different components of the malocclusion that can be assessed using the PAR index can be divided into the following:

1. Alignment of the dentition (It includes the impactions)
2. Buccal segment relationship
3. Overjet
4. Overbite
5. Discrepancies in midline

3.2.1. Alignment of the dentition (it includes the impactions that occur in a dentition)

The upper and lower anterior segment alignment are considered in this segment. Scores are recorded for both of these aligned segments. The zone for recording is from the mesial contact point of the canines on one side to the mesial contact point of the canine on the opposite side. Crowding, spacing and impacted teeth are other features that are also considered. The shortest distance between the contact points of adjacent teeth parallel to the occlusal plane is determined as contact point displacement (*Picture No. 3)* and is measured using the PAR index ruler. The greater the contact point displacement the greater is the score. (37, 38, 40, 41, 42)

Impactions of incisors and canines are recorded and a tooth is regarded as impacted if the space between the two adjacent teeth is less than or equal to 4mm. On the other hand, both ectopic incisors and canines are recorded in the anterior segment. Scores for the contact displacements and impacted/ ectopic teeth are summed to give an overall score for each anterior segment. If there exists potential crowding in the mixed dentition, average mesio-distal widths are used to calculate the space deficiency. If the space remaining for an unerupted tooth is 4mm or less, it is recorded as an impaction in the anterior segment. *Table No.1* represents the scores for the displacements and thereby helps in assessment.

3.2.1.1. Contact point displacements

Score	Displacements
0	0 to 1 mm
1	1.1 to 2 mm
2	2.1 to 4 mm
3	4.1 to 8 mm
4	Greater than 8 mm
5	Impacted teeth

Table No.1 - Scores and their respective displacements to be used while assessing the alignment of anterior segment of the dentition

Picture No. 3: Contact point displacements are measured using the PAR index ruler as shown above (It is taken from Spidlen,M.: Efektiva Ortodonticke lecby, 2003, 49)

3.2.2. *Buccal segment relationship*

The buccal segment relationship includes assessment on both left and right sides of the dentition. The teeth are scored in all three planes of space i.e. antero posterior, vertical and transverse planes as represented by *Table No. 2*. The recording zone is from the canine to the last molar, either first, second or third. All features are recorded when the teeth are in occlusion. The antero-posterior, vertical and transverse scores obtained are summed to get the relationship of each buccal segment.

Antero posterior relation	Vertical relation	Transverse relation
Score	Score	Score
0 - Good interdigitation (Class I, II, III)	0 - No open bite	0 - No cross bite
1 - Less than half from full interdigitation	1 - Lateral open bite on at least two teeth greater than 2 mm	1 - Cross bite tendency
2 - Half a unit (cusp to Cusp)		2 - Single tooth in cross Bite
		3 - More than one tooth in cross bite
		4 - More than one tooth in scissor bite

Table No.2 - Scores in all three planes of space to be used while assessing the buccal segment relationship

3.2.3. *Overjet*

The overjet section includes the assessment of positive overjet as well as the anterior teeth that are in cross bite and is represented by *Table No.3*. The recording zone includes all incisor teeth. The most prominent incisor overjet is detected and the overjet is recorded to the labial aspect of the incisal edge. When recording the overjet, the ruler

is held parallel to the occlusal plane and radial to the line of the arch (*Picture No. 4*). The presence of cross bite in the region of canine is also included under this section.

Overjet	Anterior cross bites
Score	Score
0 – 0 to 3mm	0 - No cross bite
1 – 3.1 to 5mm	1 - One or more teeth edge to edge
2 – 5.1 to 7mm	2 - One single tooth in cross bite
3 – 7.1 to 9mm	3 - Two teeth in cross bite
4 - Greater than 9mm	4 – More than two teeth in cross bite

Table No. 3 - Scores to be used while assessing the overjet
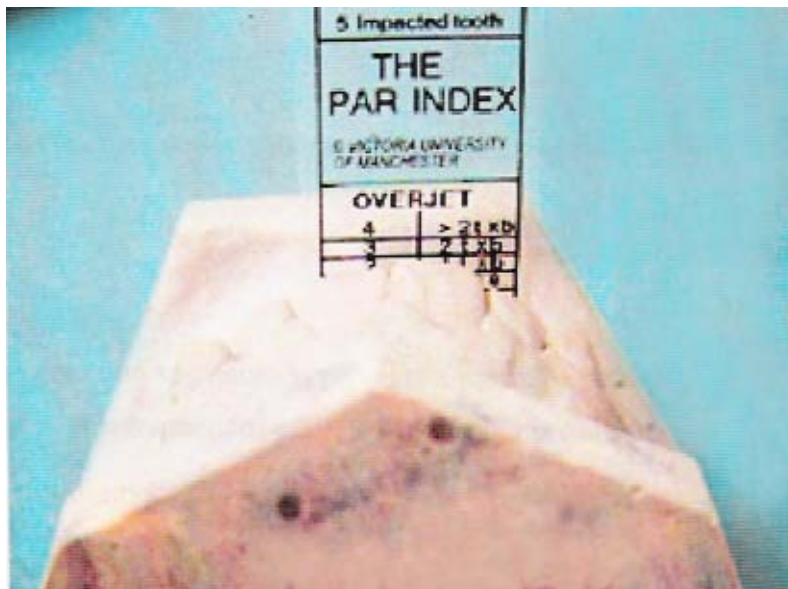
Picture No. 4: The overjet measurement is done with the help of the Par index ruler as shown above

3.2.4. *Overbite*

This section of overbite is used to record the worst vertical overlap or open bite of any of the four incisors and is assessed as suggested in *Table No. 4*. Overbite is recorded in relation to the coverage of the lower incisors or depending on the degree of open bite present.

Open bite	Overbite
Score	Score
0 - No open bite	0 - Less than or equal to one third coverage of the lower incisor
1 – Open bite less than or equal to 1mm	1 - Greater than one third but less than two thirds coverage of the lower Incisor
2 - Open bite 1.1 to 2 mm	2 - Greater than two thirds coverage of the lower incisor
3 - Open bite 2.1 to 4mm	3 - Greater than or equal to full tooth Coverage
4 - Open bite greater than 4mm	

Table No. 4 - Scores to be used while assessing the overbite

3.2.5. *Discrepancies in midline*

The midline discrepancy is recorded in reference to the lower incisor. The assessment is done as suggested by *Table No.5*.

Centerline
Score
0 - Coincident and upto one quarter lower incisor width
1 - One quarter to one half lower incisor width
2 - Greater than one half lower incisor width

Table No. 5 - Scores for recording the midline that are needed to assess the midline discrepancies

3.3. Assessment using the PAR index ruler

The PAR index measurement contains a ruler that was designed to facilitate an easy measurement for recording the malocclusion of the dentition. The ruler has certain information's in it that it is capable of summarizing the complete details and thereby is known to facilitate a quick assessment of the study.

It *(Picture No. 5)* comprises of various sections and each section depicts scores for measuring the malocclusion i.e. the first 3 sections provide a summary of the buccal occlusion in all three planes of space.i.e. antero-posterior, transverse and vertical, which are summed for each buccal segment. The next sections provide a summary of the centerline, in which the centerline is recorded in relation to lower incisor width. The overbite section allows recording of overlap in relation to coverage of the lower incisors and the open-bite section is recorded by reference to the length of the lines on the right. On the other hand the section of contact point displacement shows the length of the line that is used for matching the contact point displacements. If the distance between the contact points is greater than the line, the higher rating applies. Further the contact point displacements are summed for each anterior segment. (34)
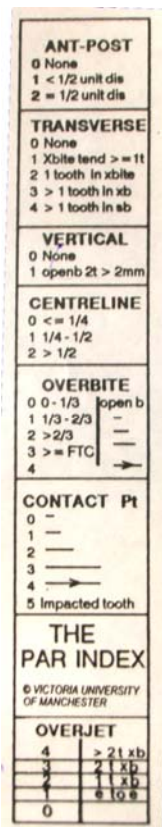
Xbite, xb- cross bite

sb- scissors bite

open b- open bite

FTC- full tooth coverage

t- tooth/ teeth

e to e- edge to edge

tend- tendency

½ unit dis- half unit discrepancy (cusp to cusp)

Picture No. 5: The PAR index ruler, it is taken from Richmond, S., O'Brien, K. D., Buchanan, I. B., Burden, D. J: An introduction to Occlusal Indices, University of Manchester, Bradford, England, Ortho-Care (UK) Ltd., 1994

3.3.1. Advantages of the PAR ruler:

1. It makes the assessment easier and faster.
2. It shows scores for each component that is to be measured.
3. It is economical.
4. It is accurate.
5. It does not require any complex systems for its use.
6. It is portable.

3. 4. Validation

Further the studies were carried out for the upliftment of PAR index and the studies were carried out by a panel of 74 dentists and 11 orthodontists and it resulted in the incorporation of certain weightings, this was done in accordance with the British orthodontic opinion (35). The various degrees of importance were attached as the weightings to the 5 components of the PAR index. The individual scores for each PAR component are multiplied by the weightings as shown below and then they are summed to establish the overall total.

Weightings for the 5 components are represented in *Table No.6* as follows:

Components	Weightings
Upper and lower anterior segment	x 1
Left and Right buccal occlusions	x 1
Overjet	x 6
Overbite	x 2
Midline	x 4

Table No. 6 - Weightings for each component of the PAR index

Each component has its own respective weightings. For example: upper and lower anterior segments were to be multiplied by 1, left and right buccal occlusions were to be multiplied by 1, overjet by 6, overbite by 2, midline by 4.

3.5. Conventions of PAR index

The PAR index conventions were put forth during its introduction (34, 35, 36, 38). These include the following:

General Conventions

- ➢ All scoring is accumulative.
- ➢ There is no maximum cut off level.
- ➢ Increased overjets, contact point displacements etc. associated with poor restorative work are not recorded.
- ➢ Contact point displacements between deciduous teeth and between deciduous and permanent teeth are not recorded.
- ➢ Spaces are not recorded if the patient is to receive a prosthetic replacement.

Canines

- ➢ Ectopic canines, which have erupted in the palate should be recorded as an anterior cross bite in the overjet section.

Impactions

- ➢ If a tooth is unerupted due to insufficient space or is ectopic, it is recorded as impacted.

Incisors

- ➢ Spacing in the anterior segment resulting from extraction, agenesis or avulsion of incisors or canines is recorded using the following protocol:
    a. If orthodontic space closure is appropriate then the space is recorded.
    b. If increasing the space is appropriate (for prosthetic replacement) then the space is only recorded if it is less than or equal to 4 mm.

- ➢ When recording an overjet, if the tooth falls on the line the lower score is recorded.

➢ If a lower incisor has been extracted or is missing an estimate of the lower dental midline is made.

3.6. Sequence followed for evaluation of study casts using PAR index.

The PAR index is known to offer uniformity, objectivity, and standardization in assessing the outcome of orthodontic treatment. This statement can be justified by evaluating the study casts. The PAR index can be applied to pre treatment and post treatment study casts. The study casts are separately assessed and scores are assigned to the various occlusal traits that make up the malocclusion. To facilitate the scoring of the study casts, a scoring system was developed and a ruler was designed (34, 42). The ruler is a summary of using the index and helps to assess individual score.

Thus to measure the dental casts using the PAR index, we require the PAR index ruler, pre treatment and post treatment dental casts and a pair of straight compasses *(Picture No. 6)*.

The Pre and the Post treatment casts are used for comparison of the treatment results and this done by scoring each component according to the rules of the PAR index. The scores are assigned with the help of the PAR ruler as it is summary of all the scores and can be applied to the study casts for the evaluation. On the other hand the compass is also used during the measurement of the study casts, i.e. the compass helps in measuring the study casts and comparing with the lines on the PAR ruler. Thus in this way the study is carried out for the evaluation of the stability after orthodontic treatment.
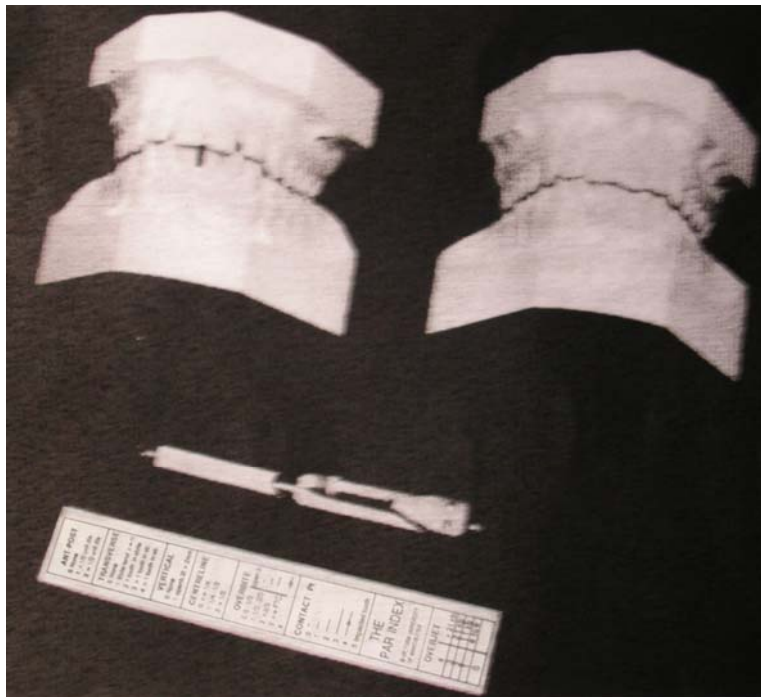
Picture No. 6: The materials that is required to carry out the study

Then the individual scores are obtained and then the individual scores with their weightings for the various components of alignment and occlusion are finally summed to obtain a total score that represents the degree a case deviates from normal alignment and occlusion. A score of zero indicates good alignment and higher scores if any indicates increased levels of irregularity. The index can also be applied to pre treatment, immediate post treatment and after few years of post treatment study casts.

The change in the score between pre treatment and the immediate post treatment indicates the degree of improvement after treatment. Further the change in the scores between the immediate post treatment and post treatment study casts after few years shows the persistence or the deterioration of the improvement that was achieved and thereby shows the success of orthodontic intervention.

Evaluation of the scores is done on the basis that zero indicates good alignment, while the higher scores are known to indicate the increased levels of irregularity.

3.7. Methods to assess persistence or deterioration of improvement

There are basically three methods of assessing improvement using the PAR index (34).

a. Absolute reduction in the weighted PAR score
b. Assessing using the nomogram
c. Percentual reduction in the weighted PAR score

3.7.1. *Absolute reduction in the weighted PAR score*

The absolute or the exact reduction in the weighted PAR score reading means the PAR score that can be obtained by deducting of the weightings of pre treatment scores with the weightings of the immediate post treatment scores. This helps in assessing the improvement.

Also on deducting the weightings of the immediate post treatment score with the weightings of the post treatment scores after few years, it is possible to determine the stability of the result.

3.7.2. *Assessing using the nomogram*

During the study, if the nomogram is used to assess the improvement of the PAR index, then a nomogram is plotted using the pre treatment weighted PAR score on the horizontal axis and the post treatment weighted PAR score on the vertical axis, i.e. the pre and the post treatment scores are read on their respective axis. Where the intercept falls, it indicates the degree of improvement that only provides three broad bands of treatment change (36, 37, 42):

1. Worse-no different
2. Improved
3. Greatly improved

Similarly the immediate post treatment scores are plotted on the x axis and post treatment scores after few years on the y axis to assess the stability. After knowing the result it is possible to categorize the results obtained. For example: A high standard of

treatment is achieved when the proportion of cases falling into "worse or no different" category of an individuals case is negligible and the mean percentage reduction in weighted PAR score is high e.g. greater than 70 percent (31, 37).
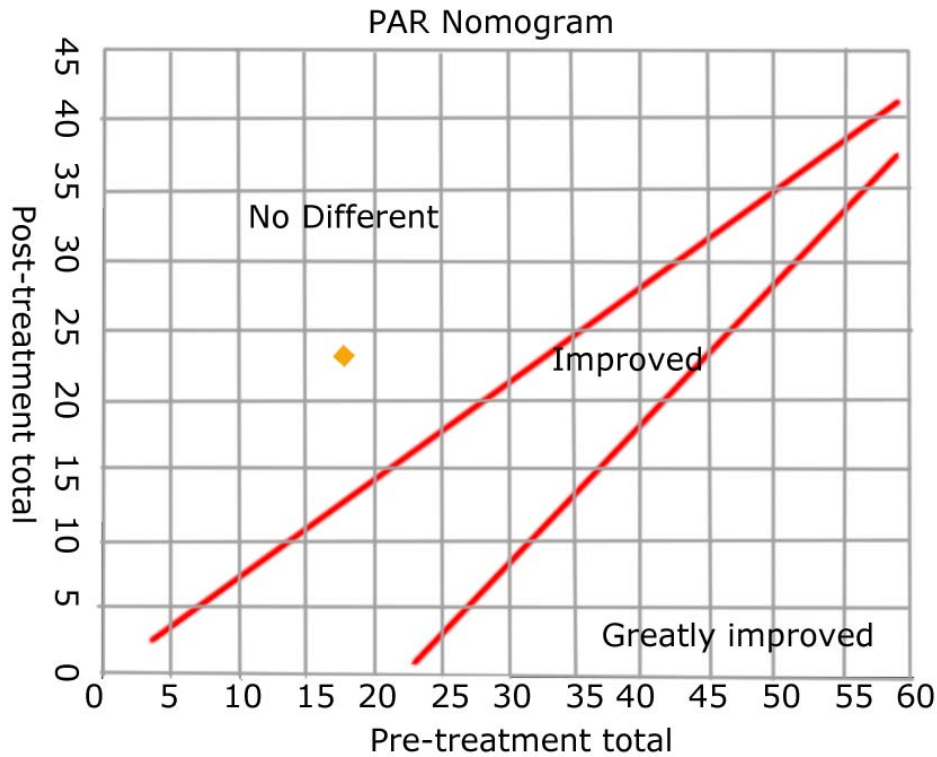
Graph No. 1: The presence of the point in the <u>No different category </u>of the nomogram indicates that the treatment was without improvement

It is possible to understand from the above Nomogam (*Graph No. 1*) that the x axis is a presentation of scores before treatment with the scores starting from 0 to 60 with a difference of 5 points between the scores. The y axis is a presentation of scores after treatment with the scores starting from 0 to 45, also with a difference of 5 points between the points. The lines in the nomogram represent the demarcation between the worse or no different cases, improved and the greatly improved bands of treatment change. The point in the no different band of treatment change indicates that the treatment was without improvement.
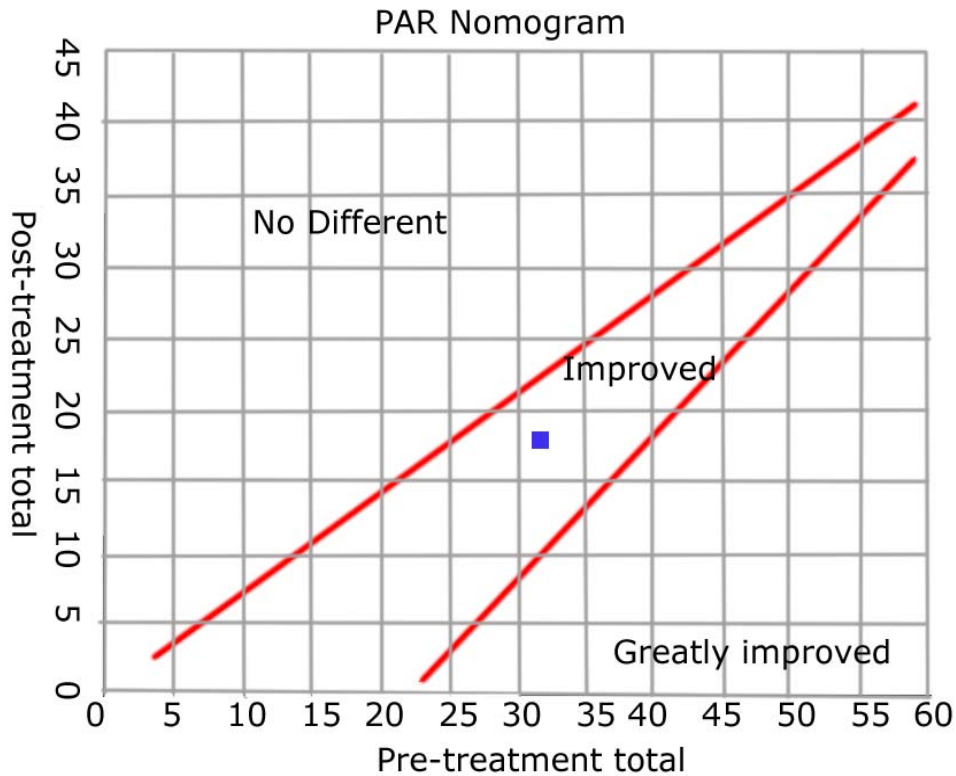
PAR Nomogram

Graph No. 2: The presence of the point in the <u>Improved category</u> of the nomogram indicates that the treatment was with good improvement

Similarly the point in the second category of treatment change shows that the treatment was with good improvement. The second category of treatment change represents PAR points of less than 22.

This category shows the significant difference after treatment. It helps a clinician to evaluate the quality of work, by helping to estimate whether there was really some significant improvement or not after treatment. For example: (*Graph No. 2)* shows the point in the improved category indicating that the treatment results were with significant improvement.
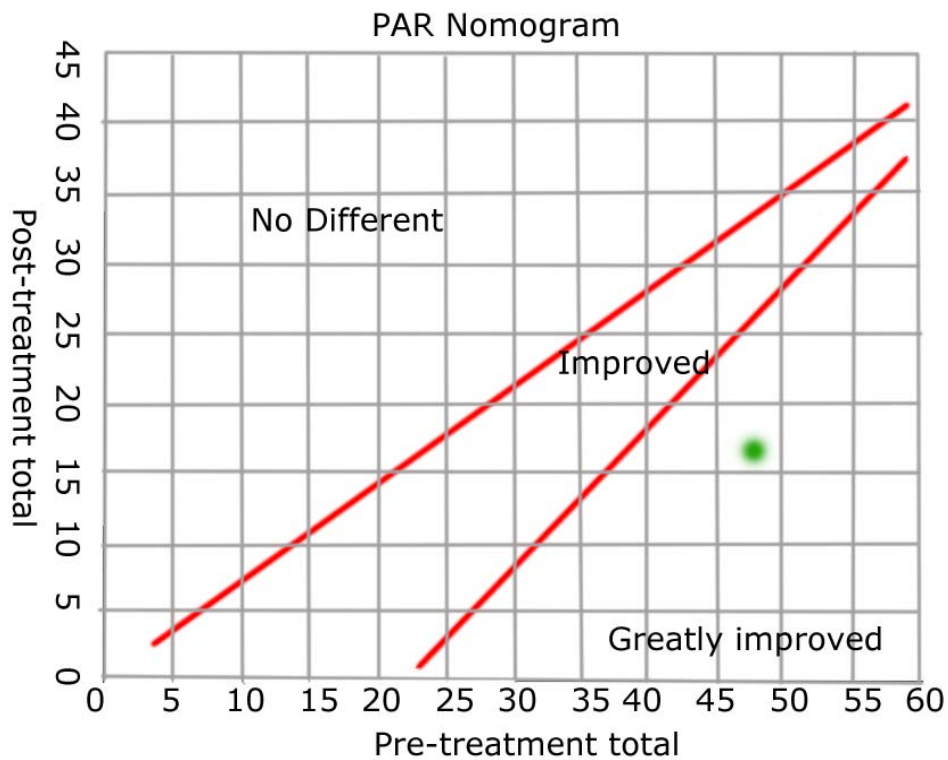
PAR Nomogram

Graph No. 3: The presence of the point in the <u>Greatly improved category</u> of the nomogram indicates that the treatment was with excellent improvement

On the other hand the point in the third category of treatment change shows that the treatment was with improvement to a larger extent. The third category of treatment change represents PAR points of greater than 22.

This category also shows the significant difference after treatment. It helps a clinician to evaluate the quality of work, by helping to estimate whether there was really greater improvement or not after treatment. For example: (*Graph No. 3*) shows the point in the Greatly improved category indicating that the treatment results were with greater improvement.

3.7.3. Percentage reduction in the weighted PAR score

The percentage reduction method of detecting the improvement of orthodontic treatment is known to reflect the change relative to the pre treatment score. Example. A case in which the score is from 4 to 10 would represent 76.9% improvement.

Accordingly a high standard of treatment was considered as being achieved when the percentage reduction in weighted PAR score was high. Example. Greater than 70%.

3.8. Evaluation and categorization of improvement

After assessing the scores obtained by any of the three methods of assessment, the result obtained can be evaluated. A high standard of treatment is known to be achieved:

> a. When the proportion of cases falling into "Worse or no different" category is negligible.
> b. When the mean percentage reduction in weighted PAR score is high.

Also, when a percent of greater than 30 % suggests that the practitioner is treating a large number of cases to a comparatively good standard. Thus in this way, the quality of work of an orthodontist can be obtained. The stages of improvement can be classified as represented by *Table No.7*.

Improvement	Nomogram classification	PAR score change (Percentual reduction)
Worse or no different	< 30%	< 30 %
Improved	>= 30 %, < 22 PAR	30 -70 %
Greatly improved	>= 22 PAR	> 70 %

Table No. 7 - The values for each stages of improvement (it is taken from Spidlen, M.: Efektiva ortodonticke lecby, Olomouc 2003, 55)

3.9. Advantages of the PAR index

The advantages in assessing stability using PAR index are:

1. It is used to eliminate subjective influences and to standardize the criteria assessed.

2. The index serves for the objective evaluation of the treatment results, i.e. it is possible to objectively and quantitively evaluate the change in the index values at the beginning and at the end of the treatment in groups of patients.

3. Effects of different methods may be also compared (44).

4. To evaluate the cost effectiveness in the treatment of class II anomalies, the occlusal PAR (Peer Assessment Rating) index also may be applied (45).

5. PAR is used to exactly define the degree of the change in teeth position after orthodontic treatment.

6. One of the features of PAR index is that it is flexible in such a way that the weighting can be changed to reflect future standards and standards of other countries (11).

3.10. Limitations of the PAR index

Studies have identified limitations associated with PAR scoring (14, 18, 23). These are as follows:

1. Problems relate mainly to the generic weighting system, particularly the respective weightings for overjet and overbite. The high weighting for overjet may influence the index to such an extent that it is unduly sensitive in any malocclusion where overjet is increased. For example reduction of an increased overjet by retroclining the upper incisors will reduce the PAR score. Thus, the aesthetic and functional benefit of such treatment may be questioned.

2. The weighting for overbite is low, so that correction of a complete and traumatic overbite merits a reduction, failing to represent treatment value in terms of function and appearance.

3. The initial PAR score is highly correlated with improvement achieved, cases with low initial scores are considered as less improved than those with high initial scores. For example: Occlusions with initial scores of less than 22 points cannot become *"Greatly improved"* after treatment.

4. The zero weighting allocated to "Displacements" in the buccal segments which include impacted teeth (7) indicates that such irregularities are disregarded even though their correction may have a significant effect on treatment outcome.

5. The studies between different countries are no longer comparable(11).

6. In children physiological growth and development might also play a role in treatment outcome, either positive and negative. Studies (1,2) have shown that the PAR scores to assess the orthodontic treatment outcome in sample population for detecting the individuals change with normal growth and development does not include the untreated control group.

3.11. Other limitations of the PAR index

The PAR index resembles the other indices in few of its limitations, they are as follows:

1. The changes in facial profile or cephalometric parameters that reflect the skeletal component of malocclusion is not considered.

2. Factors like incisor inclination, decalcification, root resorption, gingival recessions and functional and aesthetic considerations of the face is not considered.

SECTION II: EXPERIMENTAL PART

1. 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 department of orthodontics, Stomatology Clinic 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.

2. MATERIALS AND METHODS

2.1. 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.

2.2. 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.

2.3. 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 department of orthodontics, Stomatology Clinic 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.

2.4. 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.

2.5. Methods

The method was to assess this group of 69 patients using PAR index for evaluating the study after 2years 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. 8* shows the 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
5.	1	0	2	2	1	1	0
6.	2	1	2	1	1	1	0
7.	1	1	2	0	0	0	0
8.	2	4	4	4	2	1	1
9.	3	0	2	2	1	1	0
10.	1	0	1	2	1	2	0
11.	1	0	1	1	0	0	0
12.	1	1	0	1	0	2	0
13.	5	0	2	2	0	2	0
14.	0	0	2	2	0	1	0
15.	3	2	1	2	1	1	1
16.	1	1	2	2	0	1	0
17.	4	1	2	0	1	0	0
18.	1	1	2	2	0	1	1
19.	5	1	2	3	4	4	0
20.	0	0	2	1	2	3	0
21.	0	0	1	0	0	1	0

Patients	Upper anterior segment	Lower anterior segment	Right buccal occlusion	Left buccal occlusion	Overjet	Overbite	Centreline
22.	3	0	1	1	3	1	1
23.	0	0	2	3	2	2	1
24.	2	3	2	1	1	0	0
25.	0	0	3	0	2	0	2
26.	1	0	1	2	0	0	1
27.	1	2	2	1	1	0	0
28.	5	1	2	1	2	0	0
29.	5	5	3	2	2	0	1
30.	2	1	2	2	0	0	0
31.	1	4	0	0	3	1	0
32.	4	0	2	2	2	1	0
33.	1	0	2	2	0	1	1
34.	5	0	2	2	0	2	1
35.	2	4	2	2	0	0	1
36.	3	1	2	2	0	1	1
37.	3	1	0	0	1	1	1
38.	4	4	2	2	0	1	0
39.	4	2	2	1	1	1	0
40.	4	4	2	1	2	2	0
41.	5	5	2	2	0	2	1

Patients	Upper anterior segment	Lower anterior segment	Right buccal segment	Left buccal segment	Overjet	Overbite	Centreline
42.	5	4	1	2	3	2	0
43.	0	2	0	0	0	1	0
44.	2	1	1	0	0	2	1
45.	3	3	1	2	1	2	0
46.	4	2	2	2	0	2	0
47.	5	3	1	2	0	3	0
48.	5	2	2	0	0	0	1
49.	4	1	2	3	1	1	0
50.	5	5	0	1	0	1	1
51.	3	3	2	2	1	1	0
52.	6	3	3	0	3	0	0
53.	2	4	0	0	1	2	0
54.	0	4	0	0	0	2	1
55.	4	3	0	1	0	1	0
56.	3	1	2	2	1	2	1
57.	7	3	2	2	0	2	0
58.	3	1	1	2	1	1	1
59.	3	6	1	2	0	1	2
60.	3	1	2	1	1	2	1
61.	9	7	0	0	2	0	2
62.	1	1	1	1	0	0	0

Patients	Upper anterior segment	Lower anterior segment	Right buccal occlusion	Left buccal occlusion	Overjet	Overbite	Centreline
63.	4	4	2	2	0	1	0
64.	3	0	0	1	0	2	0
65.	7	0	3	2	2	0	1
66.	2	3	1	2	1	1	0
67.	5	5	1	2	1	0	0
68.	4	5	0	2	0	3	1
69.	2	3	1	2	1	1	0

Table No. 8 - The 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.9*. 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
5.	1 x 1	0 x 1	2x 1	2 x 1	1 x 6	1 x 2	0 x 4
6.	2 x 1	1 x 1	2 x 1	1 x 1	1 x 6	1 x 2	0 x 4
7.	1 x 1	1 x 1	2 x 1	0 x 1	0 x 6	0 x 2	0 x 4
8.	2 x 1	4 x 1	4 x 1	4 x 1	2 x 6	1 x 2	1 x 4
9.	3 x 1	0 x 1	2 x 1	2 x 1	1 x 6	1 x 2	0 x 4
10.	1 x 1	0 x 1	1 x 1	2 x 1	1 x 6	2 x 2	0 x 4
11.	1 x 1	0 x 1	1 x 1	1 x 1	0 x 6	0 x 2	0 x 4
12.	1 x 1	1 x 1	0 x 1	1 x 1	0 x 6	2 x 2	0 x 4
13.	5 x 1	0 x 1	2 x 1	2 x 1	0 x 6	2 x 2	0 x 4
14.	0 x 1	0 x 1	2 x 1	2 x 1	0 x 6	1 x 2	0 x 4
15.	3 x 1	2 x 1	1 x 1	2 x 1	1 x 6	1 x 2	1 x 4
16.	1 x 1	1 x 1	2 x 1	2 x 1	0 x 6	1 x 2	0 x 4
17.	4 x 1	1 x 1	2 x 1	0 x 1	1 x 6	0 x 2	0 x 4
18.	1 x 1	1 x 1	2 x 1	2 x 1	0 x 6	1 x 2	1 x 4
19.	5 x 1	1 x 1	2 x 1	3 x 1	4 x 6	4 x 2	0 x 4
20.	0 x 1	0 x 1	2 x 1	1 x 1	2 x 6	3 x 2	0 x 4
21.	0 x 1	0 x 1	1 x 1	0 x 1	0 x 6	1 x 2	0 x 4

Patients	Upper anterior segment	Lower anterior segment	Right buccal occlusion	Left buccal occlusion	Overjet	Overbite	Centreline
22.	3 x 1	0 x 1	1 x 1	1 x 1	3 x 6	1 x 2	1 x 4
23.	0 x 1	0 x 1	2 x 1	3 x 1	2 x 6	2 x 2	1 x 4
24.	2 x 1	3 x 1	2 x 1	1 x 1	1 x 6	0 x 2	0 x 4
25.	0 x 1	0 x 1	3 x 1	0 x 1	2 x 6	0 x 2	2 x 4
26.	1 x 1	0 x 1	1 x 1	2 x 1	0 x 6	0 x 2	1 x 4
27.	1 x 1	2 x 1	2 x 1	1 x 1	1 x 6	0 x 2	0 x 4
28.	5 x 1	1 x 1	2 x 1	1 x 1	2 x 6	0 x 2	0 x 4
29.	5 x 1	5 x 1	3 x 1	2 x 1	2 x 6	0 x 2	1 x 4
30.	2 x 1	1 x 1	2 x 1	2 x 1	0 x 6	0 x 2	0 x 4
31.	1 x 1	4 x 1	0 x 1	0 x 1	3 x 6	1 x 2	0 x 4
32.	4 x 1	0 x 1	2 x 1	2 x 1	2 x 6	1 x 2	0 x 4
33.	1 x 1	0 x 1	2 x 1	2 x 1	0 x 6	1 x 2	1 x 4
34.	5 x 1	0 x 1	2 x 1	2 x 1	0 x 6	2 x 2	1 x 4
35.	2 x 1	4 x 1	2 x 1	2 x 1	0 x 6	0 x 2	1 x 4
36.	3 x 1	1 x 1	2 x 1	2 x 1	0 x 6	1 x 2	1 x 4
37.	3 x 1	1 x 1	0 x 1	0 x 1	1 x 6	1 x 2	1 x 4
38.	4 x 1	4 x 1	2 x 1	2 x 1	0 x 6	1 x 2	0 x 4
39.	4 x 1	2 x 1	2 x 1	1 x 1	1 x 6	1 x 2	0 x 4
40.	4 x 1	4 x 1	2 x 1	1 x 1	2 x 6	2 x 2	0 x 4
41.	5 x 1	5 x 1	2 x 1	2 x 1	0 x 6	2 x 2	1 x 4

Patients	Upper anterior segment	Lower anterior segment	Right buccal segment	Left buccal segment	Overjet	Overbite	Centreline
42.	5 x 1	4 x 1	1 x 1	2 x 1	3 x 6	2 x 2	0 x 4
43.	0 x 1	2 x 1	0 x 1	0 x 1	0 x 6	1 x 2	0 x 4
44.	2 x 1	1 x 1	1 x 1	0 x 1	0 x 6	2 x 2	1 x 4
45.	3 x 1	3 x 1	1 x 1	2 x 1	1 x 6	2 x 2	0 x 4
46.	4 x 1	2 x 1	2 x 1	2 x 1	0 x 6	2 x 2	0 x 4
47.	5 x 1	3 x 1	1 x 1	2 x 1	0 x 6	3 x 2	0 x 4
48.	5 x 1	2 x 1	2 x 1	0 x 1	0 x 6	0 x 2	1 x 4
49.	4 x 1	1 x 1	2 x 1	3 x 1	1 x 6	1 x 2	0 x 4
50.	5 x 1	5 x 1	0 x 1	1 x 1	0 x 6	1 x 2	1 x 4
51.	3 x 1	3 x 1	2 x 1	2 x 1	1 x 6	1 x 2	0 x 4
52.	6 x 1	3 x 1	3 x 1	0 x 1	3 x 6	0 x 2	0 x 4
53.	2 x 1	4 x 1	0 x 1	0 x 1	1 x 6	2 x 2	0 x 4
54.	0 x 1	4 x 1	0 x 1	0 x 1	0 x 6	2 x 2	1 x 4
55.	4 x 1	3 x 1	0 x 1	1 x 1	0 x 6	1 x 2	0 x 4
56.	3 x 1	1 x 1	2 x 1	2 x 1	1 x 6	2 x 2	1 x 4
57.	7 x 1	3 x 1	2 x 1	2 x 1	0 x 6	2 x 2	0 x 4
58.	3 x 1	1 x 1	1 x 1	2 x 1	1 x 6	1 x 2	1 x 4
59.	3 x 1	6 x 1	1 x 1	2 x 1	0 x 6	1 x 2	2 x 4
60.	3 x 1	1 x 1	2 x 1	1 x 1	1 x 6	2 x 2	1 x 4
61.	9 x 1	7 x 1	0 x 1	0 x 1	2 x 6	0 x 2	2 x 4
62.	1 x 1	1 x 1	1 x 1	1 x 1	0 x 6	0 x 2	0 x 4

Patients	Upper anterior segment	Lower anterior segment	Right buccal occlusion	Left buccal occlusion	Overjet	Overbite	Centreline
63.	4 x 1	4 x 1	2 x 1	2 x 1	0 x 6	1 x 2	0 x 4
64.	3 x 1	0 x 1	0 x 1	1 x 1	0 x 6	2 x 2	0 x 4
65.	7 x 1	0 x 1	3 x 1	2 x 1	2 x 6	0 x 2	1 x 4
66.	2 x 1	3 x 1	1 x 1	2 x 1	1 x 6	1 x 2	0 x 4
67.	5 x 1	5 x 1	1 x 1	2 x 1	1 x 6	0 x 2	0 x 4
68.	4 x 1	5 x 1	0 x 1	2 x 1	0 x 6	3 x 2	1 x 4
69.	2 x 1	3 x 1	1 x 1	2 x 1	1 x 6	1 x 2	0 x 4

Table No.9- The scores with their respective weightings for all the 69 patients that are assessed before treatment

Thus, upon multiplying the individual scores with the respective weightings, they are summed to establish the overall total as shown by *Table No. 10*.

Patients	Overall total
1.	16
2.	30
3.	27
4.	14
5.	13
6.	14
7.	4
8.	32
9.	15
10.	14

11.	3
12.	7
13.	13
14.	6
15.	20
16.	8
17.	13
18.	12
19.	43
20.	21
21.	3
22.	29
23.	25
24.	14
25.	23
26.	8
27.	12
28.	21
29.	31
30.	7
31.	25
32.	22
33.	11
34.	17

35.	14
36.	14
37.	16
38.	14
39.	17
40.	27
41.	22
42.	34
43.	4
44.	12
45.	19
46.	14
47.	19
48.	13
49.	18
50.	17
51.	18
52.	30
53.	16
54.	12
55.	10
56.	22
57.	18
58.	19

59.	22
60.	21
61.	36
62.	4
63.	14
64.	8
65.	28
66.	16
67.	19
68.	21
69.	16

Table No. 10 – The 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. 11* 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
5.	13	2	4
6.	14	2	7
7.	4	0	0
8.	32	0	4
9.	15	0	1
10.	14	2	2
11.	3	0	0
12.	7	0	0
13.	13	5	5
14.	6	2	2
15.	20	1	2
16.	8	0	0
17.	13	1	1
18.	12	0	0
19.	43	2	2
20.	21	9	10
21.	3	0	0

Patients	Pre treatment PAR weighting score	Post treatment PAR weighting score	2 years Post treatment weighting score
22.	29	3	4
23.	25	0	2
24.	14	2	3
25.	23	11	12
26.	8	1	1
27.	12	0	0
28.	21	0	0
29.	31	0	0
30.	7	1	2
31.	25	0	0
32.	22	0	0
33.	11	0	0
34.	17	0	0
35.	14	1	1
36.	14	1	2
37.	16	0	0
38.	14	2	3
39.	17	2	2
40.	27	0	0
41.	22	4	6

Patients	Pre treatment PAR weighting score	Post treatment PAR weighting score	2 years Post treatment weighting score
42.	34	0	0
43.	4	0	0
44.	12	0	0
45.	19	0	0
46.	14	0	0
47.	19	3	5
48.	13	0	0
49.	18	0	0
50.	17	0	0
51.	18	0	0
52.	30	1	1
53.	16	2	2
54.	12	1	1
55.	10	0	0
56.	22	1	2
57.	18	0	0
58.	19	0	0
59.	22	1	1
60.	21	0	0
61.	36	2	2
62.	4	0	0

Patients	Pre treatment PAR weighting score	Post treatment PAR weighting score	2 years Post treatment weighting score
63.	14	0	0
64.	8	1	2
65.	28	2	3
66.	16	0	0
67.	19	1	2
68.	21	0	1
69.	16	1	1

Table No. 11 - Total weightings in three phases of treatment

Thus 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 nomogram.

3. 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 asessing 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. 4* as shown below.

The below Graph 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, whch 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.
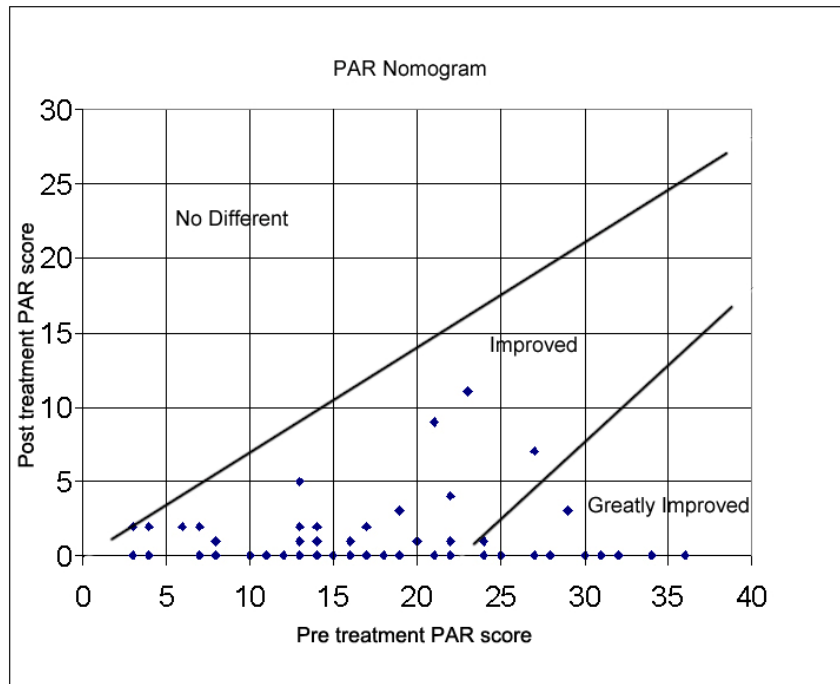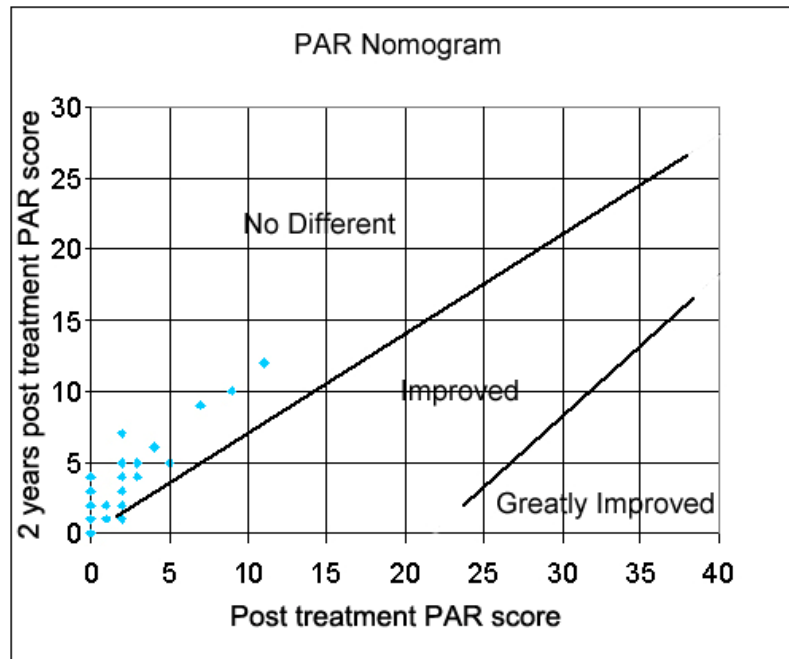
PAR Nomogram

Graph No. 4: Represents the PAR nomogram that has 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. 5*.

Graph No. 5: Represents the PAR nomogram that has 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.

4. DISCUSSION

The availability of a definition for Normal Occlusion(4) 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 neccessary to increase the subjectivity of asessing 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 assesing 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 neccesity 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. 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 triats, upper and lower anterior alignement, 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 (8, 30, 36, 43). Thus finally according to the study of Dr. Richmond, 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 department of orthodontics, Stomatology clinic in Hradec Kralove. 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 asessment 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 and thus 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. Also one of the major feature of the PAR index is that the results obtained cannot be compared with the different countries. So enough discussion and comparing of the results with other countries or with other orthodontic results is not possible.

5. CONCLUSION

In this study, the relapse pattern was comparable for a group of patients in the department of orthodontics, Stomatology clinic 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.

Thus as a conclusion, it is possible to say that the majority of the cases 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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