Quality control of orthodontic treatment – using ICON - Index of complexity, outcome and need

Bekir Koca

The Institute of Odontology
Karolinska Institutet
Sweden

Supervisor: Associate professor Lena Berglund-Stevenberg
Contents

1. Introduction
   1. Index of Orthodontic Treatment Need (IOTN)
   2. Peer Assessment Rating (PAR)
   3. Index of Complexity Outcome and Need (ICON)

2. Materials and Methods

3. Results

4. Discussion

5. Conclusion

6. Acknowledgement

7. References
Abstract

In this study a quality control of the orthodontic treatment of 30 patients between the ages of 9 and 20 years has been executed with the index of complexity, outcome and need (ICON). The patients were treated at Karolinska Institute, Department of Dental Medicine, Division of Orthodontics, by either post graduate students undergoing their education for orthodontic speciality or trained orthodontists. The pre- and post-treatment study models were assessed with ICON and the scores were calibrated by the supervisor.

RESULT: Showed a reduction of mean ICON-score of 61,4 points. 77 % of the patients had a post treatment grade of great improvement; the remaining 23 % had a substantial improvement. CONCLUSION: In this study, the complete orthodontic treatments of 30 patients at the Karolinska Institute were assessed with ICON, Index of complexity, outcome and need showing good treatment results. The ICON index was easy to learn and use.

1. Introduction

In Sweden, children between the ages of 3 until the year they turn 20 are provided dental service by the county councils. This means that all dental care is free of charge for these children including orthodontic treatment, if the treatment need is substantially high. The county councils in Sweden have gradually moved towards more stringent financial accountability and have had to handle economical limitations. This has lead to a decreased number of patients who get county council funded orthodontic treatment even though the treatment demand, especially in larger cities as Stockholm, Gothenburg and Malmo has increased. In Stockholm 25 % of the children and young adults receive an orthodontic check valid for the orthodontic treatment. Due to the fact that more and more patients are denied orthodontic treatment, it is important that we have a system in order to assess the need of treatment so that patients with the greatest treatment need get treatment. But it is equally important that we have a system for the assessment of the patient treatment outcome, for patients receiving free treatment, in order to control that the funded treatments have given satisfactory results.

The IOTN (Index of Orthodontic Treatment Need) and the Swedish Medical Board Index (SMBI) are commonly used in Sweden in order to assess the treatment need and choose the
deserving patients with great need for orthodontic treatment. A score of more than 50 or higher on IOTN index and/or a score of 3 or higher on the index of Swedish health authorities is required for orthodontic treatment funded by the county councils. The IOTN index will be described in details later.

The index of Swedish health authorities consist of a four grade scale. Beside the occlusal traits, limited consideration is taken to the patient’s desire. Patients with first and second grade objective treatment need are denied treatment in spite of the fact that a patient with second grade objective need might have a much higher subjective need. In Stockholm the patients with urgent need of orthodontic treatment receive a check. The check is valid for treatment at the clinic the patient chooses. If patients with a borderline need of treatment ask for a second opinion, this request can be granted. However as a recent study shows the conformity among orthodontists on treatment need is questionable. [1]

PAR (Peer Assessment Rating) index is an index primarily used to assess the treatment results. IOTN together with PAR index have turned out to be useful indices for assessment of treatment need and clinical quality control. [2] But, for quality control, the most desirable and optimum measurement tool would be one unified index that covers both processes; assessment of treatment need and assessment of treatment outcome. One such index; Index of Complexity Outcome and Need (ICON) was developed by Richmond and it has been proven to be a passable equipment. [3]

Cost-effectiveness in health care can be defined as ‘that intervention indicated relative to the resources consumed’. [4] In orthodontics, this is of importance to the patient, the practitioner, and most importantly to the health care provider in countries such as Sweden where the county councils covers this cost for the children with functional need. ICON has proved to be a reliable orthodontic index that can be used in cost-effectiveness studies. [5] By using this system, cost per ICON point reduction can also give a comparison of effectiveness between practitioners.

### 1.1 IOTN (Index of Orthodontic Treatment Need)

Index of orthodontic treatment and need (IOTN) was developed as a result of a government initiative. The purpose of this index was to help determine the likely impact of a malocclusion on an individual’s dental health and psychosocial well-being. It comprises two elements; one dental health component and one aesthetic component.
1.1.1 Dental health component
This was developed from the index used by the Dental Board in Sweden designed to reflect those occlusal traits, which could affect the function and longevity of the dentition. The single worst feature of a malocclusion is noted and categorized into one of five grades reflecting need for treatment.

Grade 1 – no need
Grade 2 – little need
Grade 3 – moderate need
Grade 4 – great need
Grade 5 – very great need

Following features are observed consecutively and only the single worst feature is recorded.
- Missing teeth
- Over jet
- Cross bite
- Displacement (of contact points)
- Over bite

1.1.2 Aesthetic component
This aspect of the index is meant to assess the aesthetic handicap posed by the malocclusion and thus the psychosocial impact upon the patient. A set of ten standard photographs are graded from score 1 to 10 (figure 1). The patient’s teeth, in occlusion, are viewed from the anterior aspect and the appropriate score determined by choosing the photograph that is thought to pose an equivalent aesthetic handicap. The scores are categorized according to need for treatment:

Score 1-2 – none
Score 3-4 – slight
Score 5, 6, or 7 – borderline/moderate
Score 8, 9, or 10 – definite
1.2 Peer Assessment Rating (PAR)

The PAR index was developed primarily to measure the success (or failure) of orthodontic treatment. It was developed by S.Richmond et al. [6] A number of parameters are recorded as scores, before and at the end of treatment, using study models. Unlike the index for treatment need, the scores are cumulative and the features recorded and multiplied by different numbers are:

- Crowding – contact point displacement in mm (×1)
- Buccal segment relationship – in the anteroposterior, vertical, and transversal planes (×1)
- Over jet in mm (×6)
- Over bite in mm (×2)
- Centerlines, difference from coinciding in mm (×4)
The difference between the PAR scores at the start and on completion of treatment can be calculated, and from this the percentage change in PAR score, which is a reflection of the success of treatment, is derived. A high standard of treatment is indicated by a mean percentage reduction of greater than 70 per cent. A change of 30 per cent or less indicates that no appreciable improvement has been achieved.

Although IOTN (for assessing treatment need) and PAR (for assessing outcome) are both reliable and valid indices they have some important limitations:

- The validation and development of the IOTN index has been made to assess treatment entry and exists as separate phenomena. The PAR index assesses only occlusal trait not regarding the aesthetic impact of the malocclusion. The need to use these two indices requires additional training and duplicates the effort of measuring what are often similar occlusal traits.

- Using the dental health component (DHC) and the aesthetic component (AC) when categorizing treatment can be contradictory, with one component suggesting treatment and the other lesser treatment need.

- The IOTN and PAR indices have been validated against UK-dental opinion and thus may not be representative of professional opinions in other countries. [7][8]

- The PAR index has been criticized for undue leniency of residual extraction spacing, unfavorable incisor inclinations, and rotations [9]. Other authors have found it unduly harsh on treatments with limited aims [10]

- PAR takes no account of periodontal destruction, decalcification, root resorption, dynamic occlusion, and facial aesthetics [11]
1.3 Index of Complexity Outcome and Need (ICON)

An effort has been made by C. Daniels and S. Richmond, to form a unified index; ICON, in order to use the same measurement tool to assess treatment need and to assess treatment outcome. [3] An international panel of 97 orthodontists from nine countries was asked to judge a diverse sample of study casts. This study consisted of 240 dental casts for assessment of treatment need and 98 paired pre-treatment and post-treatment cases for assessment of treatment outcome. The practitioners gave each a dichotomous decision on the need for treatment and the acceptability of the treatment outcome. Furthermore, the practitioners gave a judgment, for the pre-treatment complexity and the post-treatment degree of improvement.

The mean complexity and improvement rating was then worked out for each case. With help of Stepwise Multiple Logistic Regression, a set of five occlusal traits, which were useful to predict the practitioners’ dichotomous decisions, were identified. Further detail is presented in figure 2.

---

**Figure 2: The components in ICON and their weighting**

<table>
<thead>
<tr>
<th>Component</th>
<th>Score</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Icon Scoring Method</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Component</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Aesthetic assessment</td>
<td>Score 1 to 10</td>
<td></td>
</tr>
<tr>
<td>Upper arch crowding</td>
<td>&lt;2 mm</td>
<td>2.1 to 5 mm</td>
</tr>
<tr>
<td>Upper spacing</td>
<td>&lt;2 mm</td>
<td>2.1 to 5 mm</td>
</tr>
<tr>
<td>Crossbite</td>
<td>No crossbite</td>
<td>crossbite present</td>
</tr>
<tr>
<td>Incisor open bite</td>
<td>Edge to edge</td>
<td>&lt;1 mm</td>
</tr>
<tr>
<td>Incisor overbite</td>
<td>&lt;1/3 lower incisor coverage</td>
<td>1/3 to 2/3 coverage</td>
</tr>
<tr>
<td>Buccal segment anteroposterior</td>
<td>Cusp to embrasure only Class 1,11 or III</td>
<td>Any cusp relation up to but not including cusp to cusp</td>
</tr>
</tbody>
</table>
In this new index, the features of both the IOTN and the PAR are incorporated. The scores, mentioned below, are multiplied by its weighting:

- Aesthetic component of IOTN (X7)
- Upper arch crowding/spacing (X5)
- Crossbite (X5)
- Overbite/Open bite (X4)
- Buccal segment relationship (X3)

The study models before and after treatment are marked and scored. The total sum of markings for the initial study model gives a pretreatment score, which is said to reflect the need for, and likely complexity of, the treatment required. A score of more than 43 indicates a demonstrable need for treatment. The pretreatment scores can be graded in different levels of complexity as followed:

- Easy           < 29
- Mild           29 to 50
- Moderate       51 to 63
- Difficult      64 to 77
- Very difficult > 77

From the study model taken after the end of the treatment, the index is scored again and if the summary score is less than 31 the outcome is acceptable. Even here, the improvement grade can be leveled by using the equation below:

\[
\text{Improvement grade} = \text{pre-treatment score} - (4 \times \text{post-treatment score})
\]

The improvement grades are as followed:

- Greatly improved  > -1
- Substantially improved  -25 to -1
- Moderately improved  -53 to -26
- Minimally improved  -85 to -54
- Not improved or worse < -85
This index is criticized for the large weighting given to the aesthetic component and has not yet gained widespread acceptability. But the index has been proven to correlate with patient’s opinions of aesthetic, function, speech and treatment need. [12] The strength of association, however, was low.

In 2008 Yijin Ren et al., investigated the subjective perception and objective treatment need and complexity of a number of patients seeking orthodontic re-treatment. These patients had good perception of dental aesthetics and strong motivation. Their chief complaints were remaining dental irregularity, prominent upper anterior teeth, and/or an undesirable facial profile. The study showed that they had an objective treatment need, indicated by the ICON scores. [13]

Regarding patients treated with a combined orthodontic and orthognathic approach, a study done by K.M. Templeton et al. shows that both PAR and ICON are suitable occlusal indices for assessing outcome and improvement. [14]

**Assessing treatment outcome, ICON compared to PAR:**

ICON is a unified index that, in contrast to PAR, assesses along with treatment outcome even treatment need and complexity. The PAR index’s ability to assess complexity is limited. [15] In addition, there are different weightings systems available according to the type of malocclusion, assessment and the country in which it is undertaken. The ICON is developed to represent international opinion for all facets of malocclusions.

ICON is a relatively simple index to use requiring no hierarchy with relatively few traits to measure. Application of this index takes approximately 2 minutes for each case and therefore, it is relatively quick. It requires no measurement tools other than an ordinary millimeter rule and an Aesthetic component scale. [16]

The aim of this study is to assess ICON on patients treated at Karolinska Institute, Department of Dental Medicine, Division of Orthodontics.
2. Materials and methods

Of the 297 patients who had their complex orthodontic treatment completed year 2008 at Karolinska Institute, Department of Dental Medicine, Division of Orthodontics. (Stockholm), approximately 10 % (30 patients) were chosen from a list of patients with complete treatment with the only criteria of complete study models before and after treatment. Of these patients, 18 were female and 12 male with a mean age 14 at the start of the treatment. [Table A]. The patients were treated by both postgraduate students in orthodontics and trained orthodontists. Patients with incomplete study models were excluded and replaced with the following patient on the list. The patients had an age range between 9 and 20 years at the start of treatment. The age and gender of all patients were noted and the duration of the treatment was recorded. The ICON scores were calculated for the pre-treatment and post-treatment models. The results were calibrated by my supervisor, associate professor Lena Berglund- Steenberg.

Table A. Pre-treatment ICON scores

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>12</td>
</tr>
<tr>
<td>Female</td>
<td>18</td>
</tr>
<tr>
<td>Number treated</td>
<td>30</td>
</tr>
<tr>
<td>Mean age at start</td>
<td>14</td>
</tr>
<tr>
<td>Mean start ICON</td>
<td>70,7</td>
</tr>
</tbody>
</table>
An example of how the patients study models were assessed follows as below:
The patients pre-treatment study models (fig. 3a-3c) were evaluated as 9 on the scale of AC which was multiplied with 7 according to the calculation table. Next step in the assessment procedure is the crowding/spacing grade, in this case crowding was graded as 5 (> 17 mm) which was multiplied with 5. Crossbite was present which gave us a number of 1 and was multiplied with 5. Finally, the openbite/deepbite was evaluated along with buccal segment in anteroposterior aspect to a score of 1 and 2 respectively, both were multiplied with 4. The calculation of all these digits gave us a total pre-ICON score of 105 leading to complexity grade of very difficult (>77).
The post-treatment study models (fig. 4a – 4c) were assessed as 1 on the AC-scale. All other components, except the anteroposterior buccal relation that was scored 1 (×4), were given the score 0 giving a post-treatment ICON-score 10. In order to get the improvement grade, the following equation was used:

Pre-treatment score – 4 times post-treatment score

In this case the calculation was therefore 105-(4×10) = 65 resulting in a greatly improved outcome (> -1).
3. Results

The patients who were chosen for this study had a mean ICON score of 70.7 at the start of the treatment [Table A]. Out of these patients only two had complexity grade Easy while 13 patients had Very difficult [Table B]. The treatment had a mean duration of 24.7 months beginning from the planned extractions or bonding of the orthodontic brackets. After the complete treatment, the calculation of mean ICON score was recorded to be 9.3 showing a reduction of 61.4 ICON points [Table C]. The distribution of pre and post treatment ICON-scores for all the cases are presented in table E. None of the patients showed a lesser improvement than substantial. 23 patients; 77% showed great improvement. Remaining 7 patients, 23% showed substantial improvement [Table D].

Table B. Distribution of complexity grade

<table>
<thead>
<tr>
<th>Complexity</th>
<th>Patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Easy</td>
<td>1</td>
</tr>
<tr>
<td>Mild</td>
<td>2</td>
</tr>
<tr>
<td>Moderate</td>
<td>6</td>
</tr>
<tr>
<td>Difficult</td>
<td>7</td>
</tr>
<tr>
<td>Very difficult</td>
<td>13</td>
</tr>
</tbody>
</table>

Table C. Post-treatment ICON scores

<table>
<thead>
<tr>
<th>Category</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>12</td>
</tr>
<tr>
<td>Female</td>
<td>18</td>
</tr>
<tr>
<td>Number treated</td>
<td>30</td>
</tr>
<tr>
<td>Mean finish age</td>
<td>15.3</td>
</tr>
<tr>
<td>Mean duration (months)</td>
<td>24.7</td>
</tr>
<tr>
<td>Mean finish ICON Score</td>
<td>9.3</td>
</tr>
</tbody>
</table>
Table D. Distribution of improvement grade

Table E. Distribution of pre and post treatment ICON scores for the 30 patients
5. Discussion

Several indices have been used for the assessment of orthodontic treatment need and treatment outcome. In order to have a standardized system, it would be ideal to have an index that covers both purposes. Such an index has been proposed in form of ICON, but this index is not yet commonly used. Beside the fact that other indices have been used during many years, the ICON index has not been assessed in enough quality control studies. More quality control studies are needed in order to have this unified index as more generally accepted index.

In order to assess the outcome of orthodontic treatment with ICON index, I printed out a list of all patients who had undergone a complete orthodontic treatment and finished the treatment at Karolinska Institutet during the year of 2008. 30 patients were chosen marked randomly on the list. Having complete pre-treatment and post-treatment study models was the only criteria. Hence, 8 study models were excluded where the study models were either incomplete or too damaged to be used for this purpose. These models were replaced by the next respective names on the list.

I think ICON is a pliable index and easy to use. The only equipment needed for this purpose is a measuring ruler and study models pre- and post-treatment. The instructions for scoring and the cut off values are distinct and easy to follow. The models for the first case took around 10 minutes each to assess but when I had got more familiar with the ICON system, each patient took around 2 minutes.

ICON is the first index based on the average opinion of a large panel of international orthodontic opinions. It is developed to enable assessments of treatment need and outcome using a set of five occlusal traits and for this reason it offers clear advances on the currently used methods; IOTN and PAR.

ICON is a relatively new index and is not used widely yet. It is criticized for being a method heavily weighted by aesthetics. According to a study performed by Ngom PI et al. the treatment need was assessed for 665 Senegalese schoolchildren aged 12-13. [17] IOTN and ICON indices were used for this purpose. 42,6 % of cases assessed with the dental health
component of IOTN had treatment need while 44.1% of cases assessed with ICON had treatment need. It could be concluded that in spite of the heavily weighted aesthetic factor, treatment need according to ICON does not differ much from the results with IOTN.

Onyeaso CO and Begole EA [18] have in their study examined the relationship among 4 indices that are used to score orthodontic treatment need and outcome, and to determine whether ICON index could replace the other 3 indices: dental aesthetic index, PAR and the American Board of Orthodontics objective grading system (ABO-OGS). 100 pre-treatment and post-treatment study models were randomly selected from an accredited graduate orthodontic clinic at University of Illinois at Chicago, Chicago, Ill. This study showed that the ICON can be used in place of the PAR and the ABO-OGS for assessing treatment outcome and in place of the DAI for assessing treatment need.

A study done by S. Richmond et al. in Malmö had the aim of assessing the orthodontic treatment service provided by 6 orthodontists in a group practice. [19] The study models of 100 patients treated orthodontically in the office were assessed with ICON. 3 cases were judged as not requiring orthodontic treatment and 36 (36%) cases were classified as very difficult to treat. 71% of the cases exhibited acceptable finishes while 6% showed a continued need of treatment. The treatment on average took 22 months.

In my study all the patients chosen had a treatment need (most of them a great treatment need) according to ICON scoring system. All these patients had got an orthodontic check to get free treatment. In contrary to Richmonds study, none of my cases showed less than substantial improvement. 77% showed great improvement while 23% had improved substantially. The treatment took approximately 24 months on average.
4. Conclusions

In this study, the complete orthodontic treatments of 30 patients at the Karolinska Institute were assessed with ICON, Index of complexity, outcome and need. 77% of these cases were greatly improved, 23% showed substantial improvement while none of the patients was in need of further treatment, in other words, satisfying treatment results.

It was first time for me to come in contact with ICON and work with it. The index is simple to learn and use. After a quick calibration all you need is the pre- and post-treatment study models, and a measuring ruler.

6. Acknowledgments

I would like to thank my supervisor associate professor Lena Berglund-Stevenberg for excellent guidance, your expertise and support made this project possible. I would also like to thank the nurses Anita Johansson and Helené Bohlin at the department of Orthodontics for their help with study models and journals. Last but not least I want to thank Professor Jan Huggare for introducing me to this project.
7. References


