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A Comprehensive Diagnostic System for Orthodontists—Beyond Angle’s Classification

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Traditionally orthodontists have used the classification system developed by Edward H. Angle in 1900 to describe the malocclusion of an orthodontic patient. This classification is very limited with respect to the information it provides and should be replaced by a more detailed and inclusive description of a patient’s malocclusion as well as the underlying biology. In this review article we propose a new technique that ensures all pertinent information gets considered and we suggest a systematic approach to a more differentiated orthodontic diagnosis. Our approach divides the diagnosis into clearly defined categories that bring together the clinical findings into a comprehensive diagnosis.

Keywords: differential diagnosis; dental development; occlusion; space conditions; function; stage of maturation; facial growth pattern.

BACKGROUND

It has long been the tradition in orthodontics to use the diagnostic categories or classification created by Edward H. Angle around 1900. His classification of malocclusions was based on looking primarily at the first molars and dividing the different malocclusions into groups that he labeled Class I, II and III. In addition, he also described the anterior occlusion as either Div. 1 or Div. 2 in cases with a Class II molar relationship. The terminology used to divide malocclusions has until now been the chosen norm. Unfortunately, it has frequently led to standardized treatment protocols for each Class without further attempts to differentiate the malocclusion based on its etiology nor if the individual’s facial components were contributing to the problem. In all fairness, it should be remembered that at the time Angle introduced his classification system X-rays were not available that could have provided more information about the facial morphology of the patient.

When Broadbent in the US, and Hofrath in Germany in 1931 introduced the use of cephalometric headplates, a whole new chapter with respect to understanding the facial components and their contribution to a patient’s malocclusion, was introduced. New norms for facial morphology were developed and studies of the facial make-up of individuals and groups began to appear in the literature. Despite a few attempts to create a more differentiated understanding of malocclusions the orthodontic specialty is for the most part, still limited to the classification of malocclusion by Edward H. Angle introduced almost 30 years prior to the introduction of cephalometry.

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Aims:

1) To create a dialogue around the problems of developing a differentiated diagnostic system in orthodontics that can replace or supplement the traditional Angle classification.

2) To introduce a more differentiated diagnostic system than the simplistic Angle classification that has been used for so many years. Based on studies in Epidemiology, where more detailed and descriptive grouping systems have been used, we now have available much more data that greatly can improve our diagnosis and the treatment of the patients.

History of Orthodontic Diagnosis

The first known use of the word diagnosis, according to Merriam-Webster, was made in 1634. The word is Greek in origin and means to “distinguish” and from the word diagnosis “to know”, according again to Merriam-Webster. This is exactly what it is meant to be, namely “the identification of the nature of an illness or other problem by examination of the symptoms”. In principle, this is precisely our duty in orthodontics, but the lack of a logical and systematic approach may let us fall short.

In many orthodontic graduate programs, the diagnostic part is limited to a so-called “problem list.” This is an unorganized way of listing findings from the intraoral examination, the cephalometric analysis and signs, the TMJ status, and symptoms the patient may have reported. This leaves the possibility that something important can easily be left out when planning the treatment. Typically, the problems are related to the Angle classification per se, which provides very little information except what can be observed by checking the occlusion and the facial appearance.

An assessment of the Angle classification’s reliability was discussed by Gravely et al. who studied the inter-operator reliability between several examiners in diagnosing malocclusions. They stated, “there is a high degree of error within examiner levels, for example, in categorizing Angle Class II, Div. 2 malocclusions”. They further concluded that comparisons in communities should be made by the same examiner when using the Angle classification system. Finally, they stated that “Angle’s classification system is questionable when used by both clinicians in their practice and for epidemiological studies.”. Helm, S. pointed out that the Angle classification was not sufficiently differentiated to be valuable for epidemiological studies and that individual morphological traits were not adequately defined, due to the complexity of malocclusions. Whereas this criticism, when applied to scientific epidemiological studies may be appropriate, the same complaint of lack of detail or specificity of Angle’s classification can also be applied to conventional clinical practice.

In another study of the reliability of the Angle classification, Katz, MI, evaluated whether or not orthodontists are consistent when classifying malocclusions according to Angle’s method. The results showed a significant disagreement among orthodontists in their classification of the dental malocclusion.

Using four orthodontists from one dental school, Sinh, Q. et al. compared the reliability of three methods of classifying the malocclusion. The dental casts were selected from a pool of 350 orthodontic cases that were deemed the most atypical. The Katz classification proved more reliable than the British or the Angle classification system. The Angle classification was the least reliable. There is ample support in the literature for the need to update and expand the Angle classification and make it more up to date with respect to the information included in a differential diagnosis for the individual orthodontic patient.

A new method for epidemiological registration of malocclusion was developed and introduced in 1963 and tested by Björk, Krebs and Solow on larger samples of children. They had long felt that the conventional approach to classifying malocclusions using the Angle classification was far too simplistic and that a more detailed and precise system was needed for epidemiological studies. Their initial approach was to divide the malocclusions into the following three parts.
A. Anomalies in the dentition (tooth anomalies, abnormal eruption and misalignment of individual teeth)

B. Occlusal anomalies (deviations in the positional relationships between the upper and lower dental arches)

C. Deviations in space conditions (spacing or crowding of the teeth)

Later they developed the same system for clinical use to include even more categories. The main categories of this expanded clinical Diagnostic system are listed in Figure 1, where it can be seen that the Diagnosis is divided into several categories that each holds information about a separate area. These categories are then further subdivided into a number of topics. In the following we shall be looking at each of these well-defined and important groups of symptoms.

Each of the subgroups that contribute with information to the final Diagnosis, are listed in Figure 2. These groups include the initial clinical examination, intra oral examination, radiographic analysis of a conventional headfilms and Panorex or a CBCT from which lateral headfilms and a Panorex can be developed. Finally, information from study casts, that can be either mounted or unmounted depending on the individual needs of the case, or electronic models based on an intraoral scan.

**Diagnosis of Dentition**

This diagnostic category includes all deviations or anomalies in the dental development (Figure 3A). It should also include the stage of dental maturation, as previously described by Björk et al. \(^3\) and Helms. \(^6\) A great benefit of using dental stages (DS) is that they each stage is clearly defined and include groups of teeth that are either erupting or fully erupted in a simple well-defined way, making communication with colleagues easier. Teeth that cannot erupt for various reasons or are missing are not considered. The dental maturation stages are listed in Figure 3B.

The stages indicated are separated into the two major groups where one includes incisors, cuspid and premolars (DS01, 02…). These stages again represent either teeth erupting or teeth fully erupted.

The other group, the Molar Stage, relates to the molar developmental stage (M0, 1, 2, 3). Here the molar...
stage is based on the fully erupted molars in occlusion. The stage of dental maturation can look like this: DS2, M1, meaning all incisors fully erupted and first molars also fully erupted.

In the diagnostic category labeled Occlusion, we subdivide the occlusion of the teeth into the three dimensions; Sagittal, Vertical and Transverse. The information in each of these categories is obtained from the study casts and measurements of the lateral headfilm. By using this clear and organized approach we can avoid missing important information that can be relevant for the summary Diagnosis that helps the orthodontist develop a treatment plan that meets the needs of the individual patient.

**Diagnosis of Occlusion**

**Sagittal:**
- Molar and Canine occlusion (1/2 or 1/1 cusp)
- Overjet (mm)
- Skeletal or dentoalveolar malocclusion
- Sagittal jaw relationship
- Maxillary and mandibular position
- Dentoalveolar compensatory or dysplastic development

(only applicable when a skeletal malocclusion is present)

**Vertical:**
- Overbite (mm)
- Skeletal or dentoalveolar malocclusion
- Vertical jaw relationship
- Maxillary or mandibular inclination
- Dentoalveolar compensatory or dysplastic development (only applicable when a skeletal malocclusion is present)

**Transverse:**
- Cranial base morphology
- Mandibular morphology

**Dentitional Anomalies**
- Stage of Dental Maturation (DS2, M1)
- Missing teeth
- Ectopic teeth
- Transpositions
- Supernumerary teeth (Mesiodens)
- Abnormally shaped teeth
- Impactions
- Third molars

*Figure 3A. Clinical diagnostic system.*

*Figure 3B. Diagnosis of dental maturation stage.*
In the diagnostic category labeled Occlusion, we subdivide the occlusion of the teeth into the three dimensions; Sagittal, Vertical and Transverse. The information in each of these categories is obtained from the study casts and measurements of the lateral headfilm. By using this clear and organized approach we can avoid missing important information that can be relevant for the summary Diagnosis that helps the orthodontist develop a treatment plan that meets the needs of the individual patient.

The inclusion of information about dentoalveolar compensations obtained from the cephalometric analysis is an important part of the diagnosis. These changes often can affect the treatment plan and the orthodontic correction needed. Björk et al. pointed this out on several occasions and noted that during eruption of the teeth they often tend to even out positional changes of the jaws. They also said that “when such compensation does not occur defective occlusions and space anomalies will often result”. A typical example of this can be seen in patients with Class II Div. 1 malocclusions with a skeletal discrepancy between maxilla and mandible, where the lower incisors are proclined and the upper incisors retroclined. If these dentoalveolar compensations are not taken into consideration they can prevent the correction of the Class II molar malocclusion. Keep in mind that an increased overjet, as an example, can be the result of a number of combinations of dentoalveolar and skeletal discrepancies. Figure 4 shows that various combinations of dentoalveolar relationships, inclination of the incisors and skeletal relationships each or in combination can contribute to an increased overjet. The illustration in Figure 4 shows that an increased overjet can develop as a result of a number of different combinations of dental, alveolar and skeletal difference between the upper and lower jaw. An increased alveolar protrusion or retrusion (1-2), proclination of the upper or retroclination of the lower incisors or combination thereof can be the cause of the increased overjet. Also, skeletal protrusion of the upper jaw or retrusion of the lower jaw or combinations of these can result in an increased overjet. In fact, as many as 243 combinations (35) are possible between these factors which demonstrates the importance of a detailed cephalometric analysis in order to determine where the actual problem lies when the patient is diagnosed with an excessive overjet.

Compensatory and Dysplastic Development

It should also be remembered that in some patients, where there are so-called dysplastic dentoalveolar changes, these changes can make a correction more difficult and extend the treatment time. One example, often seen in patients with an open bite is that the tongue is interfering with the closure of the open bite, affecting the eruption of the anterior teeth and preventing the normal compensations from taking place. If this is present it can be seen in the measurement of the upper end lower dentoalveolar measurements, also called the maxillary and mandibular zones, as described previously by Björk, Solow, and Nielsen.

The terms compensatory or dysplastic are only applicable in patients where there are existing skeletal discrepancies in any of the three dimensions, since they are related to the skeletal problem present. In other cases, they are referred to simply as dentoalveolar changes.

Figure 5A shows a patient with dysplastic dentoalveolar development where both the lower and the upper incisors have not erupted enough to close the bite or mask the vertical skeletal problem. Dysplastic dentoalveolar development, is most likely the result of an extensive finger sucking habit that also has led to the proclination of the maxillary incisors.

The subject in Figure 5B has an increased sagittal jaw relationship, that is partially masked by compensatory proclination of the lower incisors reducing the overjet resulting from the skeletal discrepancy. The skeletal deep bite seen in the same subject is primarily due to overeruption of the lower incisors due to lack of upper incisor contact during eruption.
Diagnosis of Dental Space

- Maxillary arch
- Crowding
  - Mild, moderate, severe
- Spacing
  - Mild, moderate, severe
- Mandibular arch
- Crowding
  - Mild, moderate, severe
- Spacing
  - Mild, moderate, severe

Diagnosis of Oral Function

- Periodontal status
- Habits
- Sucking (digits), tongue thrust, clenching or grinding
- TMD dysfunction
- Joint sounds, clicking-crepitus etc.
- Range of mandibular motion-opening/closing, lateral movement
- Airways
- Breathing pattern, nasal obstructions, adenoids, tonsils, septal deviations, turbinate size, allergies etc.
- Sleep apnea

Some malocclusions are to a great extent caused by functional factors. Examples of these are listed above.
and include habits, TMJ/TMD dysfunction, sleep apnea, and a large number of other factors. It is therefore in all instances important to include any such abnormalities in the diagnosis, so they are taken into consideration and not forgotten when the treatment protocol is developed.

- Pre-pubertal
- In puberty
- Post puberty
- Adult (growth completed)

Stage of Maturation

An important part of the diagnosis is to establish the stage of maturation of the patient. It is particularly valuable to know where the patient is on his or her growth curve in patients with skeletal discrepancies. Far too often has the orthodontists relied on the dental development or the chronological age when deciding on treatment mechanics or whether or not it is a good time for extraction of teeth in cases with crowding. Misjudging the patient’s stage of maturation can result in a poor treatment outcome, but also extend the treatment time beyond what would have been realistic had the clinician known where his patient was in terms of the physical maturation.

A simple hand-wrist X-ray can in most cases provide the needed information about the stage of development, or as now often recommended the maturation stage of the cervical vertebrae. Studies show, however, that the hand wrist is more accurate in showing the patients stage of maturation. If your treatment involves dependence on growth the hand wrist might be preferred.

Growth prediction

- Growth intensity
- Residual growth expected
  - (Extensive, moderate, limited)
- Direction of mandibular growth
- Growth rotation of the mandible (expected)

It has often been argued that predicting or forecasting facial growth is a very inaccurate and imprecise endeavor. However, numerous studies by Björk and Björk et al. have shown that prediction of mandibular growth rotations can be done with a high degree of success in the more pronounce cases, with certain structural signs. These cases may show a strong tendency to either forward or backward rotation of the mandible during growth, which can greatly influence the treatment plan and the mechanics to be used.

It is also important to know about these potential growth changes as they may influence the timing of treatment. In
some cases, the clinician may decide to delay treatment until most of the patient’s facial growth is completed. In other cases, it may be best to begin interceptive treatment early to prevent further deterioration of the malocclusion.

Predicting growth rotation can affect the type of retention and the length of the period as well as the post treatment stability. Predicting growth does not relate directly to the amount of condylar growth a patient may have during treatment, but instead to the growth changes expected. Of great importance is the anticipated amount and direction of mandibular growth. This can only be done after the stage of maturation has been determined. This part is more imprecise as the natural growth changes vary considerably and are difficult to predict. Add to this the influence of the orthodontic mechanics to be used during treatment which may affect the displacement of the mandible to a greater or lesser degree. Regardless, it is still valuable to predict future growth potential especially around puberty in patients where compensatory extractions might be considered. A similar challenge applies to patients where continued mandibular growth could be critical, as in patients with Class III malocclusion.

**CASE DEMONSTRATION**

To demonstrate the application of this diagnostic system, we present a patient (Figure 7). This young man has a Class II, Div. 1 malocclusion with an excessive overjet and a deep bite. We have collected all the information needed to develop a complete diagnosis.
Figure 7. Lateral cephalometric tracing with analysis based on Björk’s cephalometric morphological analysis.
DIAGNOSIS: (PT. R. M. 15 YRS. 9 MOS.)

Dentition:

- DS4 M 2 All teeth present including third molars

Occlusion:

Sagittal:
- Class II, Div. 1, Deep bite. The sagittal malocclusion is dentoalveolar and due to dentoalveolar retraction in the mandible. In the maxilla there is dentoalveolar protrusion with proclination of the upper incisors.
- The severe overjet is due primarily to proclination of the maxillary incisors associated with a lower lip dysfunction. The mandibular incisors also show pronounced proclination.

Vertical:
- The deep bite is skeletal and due to a reduced vertical jaw relationship. The lower incisors show dysplastic over eruption into a deep overbite with gingival impingement

Transverse:
- The transverse occlusion is normal both anteriorly and posteriorly

Space conditions:
- Normal space conditions in both the upper and lower dental arch
- Midline diastema in the upper dental arch

Function:
- Lower lip dysfunction during swallowing and at rest
- Normal TMJ function with normal range of mandibular movement
- Normal airways

Stage of Maturation:
- Post puberty

Growth prediction:
- Downward forward growth. Moderate mandibular growth due to stage of maturation.
- Moderate anterior rotation expected

DISCUSSION

We have reviewed studies critical of the Angle classification system of malocclusion for its lack of detail and specificity. This classification of malocclusion was introduced more than one hundred years ago, and now several authors recommend updating to include additional relevant diagnostic information. We introduce here a new system to help organize the orthodontic diagnosis into clearly defined categories. This will help clinicians reduce errors and omissions when collecting relevant and clinically important information about each patient. We maintain the Angle classification and expand and improve it with well-defined categories to ensure that all important treatment planning information is collected and organized.

The categories we have suggested originated from Björk, Krebs and Solow’s classification system for epidemiological registration of malocclusion and has been used extensively in studies of malocclusions in the Scandinavian countries. This system has been adapted to the specific needs of the individual orthodontic practice and we have added and subtracted categories from the original study design to better fit into the modern practice needs. In other words, this system is more than just an organized approach to help in planning treatment, it is also intended as insurance against missing important details when gathering patient information.

When Edward H. Angle introduced his classification of malocclusion, he did not have the benefit of cephalometric headfilms or dental x-rays, which provide a wealth of information about the patient. He relied on clinical observations and based his diagnosis of malocclusions solely on intraoral and facial findings.
Fortunately, we now have infinitely more information available, but this data must be gathered and available in an organized fashion. Our system is designed to do this effectively.

**SUMMARY**

- A new system of Orthodontic Diagnosis is introduced which enables more organized and reliable collection of pre-treatment information and data about the individual patient prior to treatment planning.
- The system is based on epidemiological studies, where very specific categories were used to ensure precise data collection. It is modified to be used in clinical practice.
- The system is not intended to replace the traditional Angle classification but to enhance the organized collection of information from the patients records into well-defined categories in order to provide a more differentiated and complete diagnosis.

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**REFERENCE**

# APPENDIX

Convenient Check Lists for Orthodontists

## [Sheet 1: Diagnosis System]

### Dentition
- Stage of Dental Maturation (☐ deciduous, ☐ mixed: DSM, ☐ adult)
- Number:
  - Missing:
  - Supernumerary:
- Abnormal shape:
- Abnormal eruption:
  - Impaction:
  - Third molars:
  - Tipped:
  - Rotated:

### Occlusion
- Sagittal:
  - Molar relationship:
  - Canine relationship:
  - OJ (mm):
  - Skeletal or dentoalveolar
  - Sagittal jaw relationship
  - Maxillary position:
  - Mandibular position:
  - Dentoalveolar
    - Upper: ☐ compensatory ☐ dysplastic
    - Lower: ☐ compensatory ☐ dysplastic
- Abnormal morphology
  - Cranial base:
  - Maxilla:
  - Mandible:

### Transverse:
- Anterior occlusion:
  - Midline deviation
  - Maxilla
  - Mandible
    - Skeletal
    - Dentoalveolar
  - Posterior occlusion:
    - Buccal crossbite: ☐ Unilateral, ☐ Bilateral;
    - Corpuskeletal, ☐ Dentoalveolar
    - Lingual crossbite: ☐ Unilateral, ☐ Bilateral;
    - Corpuskeletal, ☐ Dentoalveolar

### Space conditions
- Maxillary arch
  - Crowding
    - ☐ Mild, ☐ Moderate, ☐ Severe
  - Spacing
    - ☐ Mild, ☐ Moderate, ☐ Severe
- Mandibular arch
  - Crowding
    - ☐ Mild, ☐ Moderate, ☐ Severe
  - Spacing
    - ☐ Mild, ☐ Moderate, ☐ Severe

### Function
- Periodontal status
- Habits
- Sucking (digits), tongue thrust, clenching or grinding
- TMD dysfunction
  - Joint sounds, clicking-crepitus etc.
  - Range of mandibular motion-opening/closing, lateral movement
- Airways
  - Breathing pattern, nasal obstructions, adenoids, tonsils, septal deviations,
turbinate size, allergies etc.

- Sleep apnea

**Stage of Maturation:**
- Pre-pubertal, In puberty, Post puberty,
- Adult (growth completed)

**Growth Potential**
- Growth intensity
- Residual growth expected- (Extensive, moderate, limited)
- Direction of mandibular growth
- Growth rotation of the mandible (expected)

[Sheet 2: Data collection and notes]

**Clinical Examination**
- Facial Proportions:
  - Asymmetry:
  - Mandibular Function:

**Intra Oral Examination**
- Occlusion:
- Periodontal Status:
- Dental History:

**Radiographic Analysis**
- Cephalometric Headfilms:
  - Lateral and Frontal:
  - Hand wrist:
  - CBCT:

**Study Casts**
- Mounted casts
- Un mounted casts
- Diagnostic set-up