Dentoskeletal overjet: A New Method for Assessment of Sagittal Jaw Relation

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Abstract: Dentoskeletal overjet: A new method for assessment of sagittal jaw relation

Purpose: to develop a new method for assessing sagittal jaw relation and to test its accuracy in relation to the conventional methods used.

Methods: Two hundred and fifty patients aged 18-24 years were selected for cephalometric analysis to apply the applicability of new method and compare results with conventional methods [ANB angle, Wit's appraisal and A-B difference (NV)].

Results: there is a statistically significant ($P < 0.05$) agreement between the four methods used. The new measurement showed very good agreement (Kappa = 0.839) with (Two or total agreement). This agreement was statistically significant. So, the most reliable method in relation to two or total agreement was the new method, followed by A- B diff (NV) then ANB. Wits appraisal showed the lowest reliability.

Conclusion: Dentoskeletal overjet could be used for better assessment of sagittal jaw relation which is critical in orthodontic diagnosis and treatment planning.

Key words: Dentoskeletal, overjet, sagittal, jaw, Relation

INTRODUCTION

In orthodontic diagnosis, great emphasis has been considered to evaluating the sagittal jaw base relationship. This may be clinically achieved by an overall view of the patient profile (Barnett, 1975), but a more accurate evaluation may be given by palpating the anterior surfaces of the basal part of the both jaws with teeth in occlusion (Mills, 1970). Angle in 1907 provided one of the first assessments of jaw base relationship based on the first permanent molar relationship; however, this was just representative of the anteroposterior dental relationship (Angle, 1907). With the introduction of cephalometry, a new era began in orthodontic diagnosis and treatment planning. Both linear and angular measurements have been included into various cephalometric analyses to help the clinician in diagnosing anteroposterior discrepancies and establishing the most appropriate treatment plan.

Routinely, the ANB angle (Riedel, 1952) and the Wits appraisal (Jacobson, 1975) have been considered as the most common cephalometric tools for assessing anteroposterior jaw discrepancies. The first and commonly used method in orthodontic literature is the ANB angle (Riedel, 1952). Because angular measurements are geometrically sensitive and can give false results (Taylor, 1969; Beatty, 1975; Jacobson, 1975; Jacobson, 1976; Ferrazzini, 1976; Kim and Vietas, 1978; Brown, 1981 Freeman, 1981; Hussels and Nanda, 1984 and 1987), so many linear measurements have been introduced to determine the anteroposterior relationship of the jaws: the distance between perpendiculars drawn from the sella-nasion line to Points A and B (Taylor, 1969), Wits appraisal (Jacobson, 1975), the anteroposterior dysplasia indicator (Kim and Vietas, 1978), the distance between perpendiculars drawn from the Frankfort plane to Points A and B (Chang, 1987; Hussels and Nanda, 1987), the distance between perpendiculars drawn from the palatal plane to Points A and B (Nanda and Merrill, 1994) and the distance between perpendiculars drawn from the bisector of the maxillomandibular plane angle to Points A and B (Hall-Scott, 1994; Ferrario et al., 2002). A second widely used method, the Wits appraisal (the distance between perpendiculars drawn from the occlusal plane to Points A and B) was introduced by Jacobson to overcome problems of the ANB angle (Jacobson, 1975). In a simplistic view, the relationship between both the maxilla and the mandible considering the anterior cranial base (ANB) is refined by a local jaw measurement (Wits) to reduce its interferences. Combination of both ANB and Wits, each complementing the other, could better diagnose anteroposterior skeletal discrepancies and address treatment strategies. Because both ANB and Wits assess the same discrepancy, they should have good agreement. In reality, the correlation between both of them is not as strong as expected (Rotberg et al., 1980; Bishara et al., 1983; Järvinen, 1988; Hurmerinta et al., 1997); this suggests weakness in at least one assessment method.

The A-B difference (NV) is an alternative measurement that is based on linear measurement of the difference in distances between nasion perpendicular and points A and B (McNamara, 1984; Chang, 1985).

Using the three most commonly used methods in orthodontic literature and considering the agreement of two or all of them is the right way in assessment of sagittal discrepancies. If a method has been developed that could coincide with two or all three of those documented methods; then this method could be considered as a substitution for all those routinely used methods.

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A new linear measurement method has been developed and named the dentoskeletal overjet. This depends on two basic principles; the first is the dentoalveolar compensation for underlying skeletal base relation; and the second is the overjet that remains due to incomplete dentoalveolar compensation as a result of large skeletal discrepancy.

**MATERIAL AND METHODS**

**Sample Selection:**
Two hundred and fifty output patients [125 males and 125 females] aged 18-24 years were randomly selected for cephalometric analysis to validate the new method. All patients were selected from Faculty of Dentistry, Ibb University (Republic of Yemen); 103 subjects with a Class I molar relationship, 91 with a Class II molar relationship, and 56 with a Class III molar relationship.

**Selection Criteria:**
1- Full set of permanent teeth except wisdom teeth.
2- No previous trauma or operation in the craniofacial region.
3- No history of orthodontic treatment.

**Clinical Examination:**
Case histories were recorded and clinical examinations carried out to ensure that the subjects fulfilled the criteria. The molar relationship was assessed according to the mesiobuccal cusp of the upper first permanent molar: Class I when the mesiobuccal cusp occluded in the buccal groove of the lower molar, Class II when the lower molars were positioned distally relative to the upper molars, and Class III when the lower molars were positioned mesially relative to the upper molars.

**Cephalometric Analysis:**
All lateral cephalometric radiographs were taken with an Orthoralix SD2-1997 (Gendex Dental Systems, Milan, Italy) at 75-80 Kv, 10 mA per second, at the Faculty of Dentistry, Ibb University, Republic of Yemen. Throughout the investigation the distances, focus–film and film–midline plane, were kept constant with magnification factor of 1:1.1.

Lateral cephalometric radiographs were hand traced on 8” x 10” matte acetate papers of 0.003-mm thickness {the international orthodontic services (IOS); Houston, Texas, US} and a sharpened 2H lead-drafting pencil. Intra-examiner reliability was assessed by retracing of (10%) of the sample cephalometric radiographs by the same researcher (MS) in one month; also inter-examiner reliability was assessed by retracing the same (10%) of the sample cephalometric radiographs by two other orthodontists with a minimum of 15 years experience.

The cephalometric landmarks used showed in (Fig 1 a). The measurements used [ANB, A-B difference (Na perpendicular) and Wits appraisal] showed in (Fig 1 b and 1 c).

**Landmarks of the New Method (Fig 1a):**
Incisolabial line angle (point 1): The junction between the labial surface and incisal edge of the most prominent lower central incisor.
Incisopalatal line angle (point 2): The junction between the palatal surface and incisal edge of the most prominent upper central incisor.

**Measurements of Dentoskeletal Overjet Includes (Fig 2):**
1st measurement: NB- Point 1: The horizontal distance between (point 1) and the conventional NB line.
2nd measurement: NA-point 2: The horizontal distance between (point 2) and the conventional NA line.
Overjet: Distance between (point 1) and (point 2) in a tangent way to both.
Final measurement of dentoskeletal overjet = (1st measurement) + Overjet - (2nd measurement).
The following should be considered:
1- In case of increased overjet only the overjet more than 2mm (maximum normal value) was used in the equation i.e. if the overjet was 8mm only 6mm was used in the equation. In case of edge to edge incisor relation or anterior cross bite the overjet was negative carrying the sign (-) in the equation as point 1 was in front of point 2.
Fig. 1: Cephalometric landmarks and measurements used in the study.

Fig. 2: Diagrammatic representation of new method.

Fig. 3: a) In this diagrammatic representation the final measurements = \(2\text{mm} - 1\text{mm} = 1\text{mm}\) (skeletal Class I), overjet was not included in the measurements as it is within the normal value (0-2mm).

b) The final measurements = \(2\text{mm} + (6\text{mm}) - 3\text{mm} = 5\text{mm}\) (skeletal Class II), overjet is 8mm but 6mm was included in the equation as 2mm is the normal value of overjet.

c) The final measurements = \(-2\text{mm}\) (point 1 located behind NB line) + \((-3\text{mm})\) – \(3\text{mm}\) (point 2 located behind NA line) = \(-8\text{mm}\) (skeletal Class III), overjet is -3 as it is reversed and takes sign (-).

2- In cases where it was difficult to identify exactly the most protruded tooth or even the upper or lower incisor points; any closer two points was taken as the measured distance between them (the overjet) is the compensating factor in this method.
Subjects were classified as skeletal Class I when measurement ranged between -1 and +2.5mm, skeletal Class II if its (> 2.5mm) and skeletal Class III when it is (<-1mm). All other measurements of ANB, Wits, and A-B difference (Na perpendicular) compared with cephalometric norms for adults Yemeni population (Alhumam, 2007).

**Method Error:**
Method errors were calculated by Dahlberg's formula (Dahlberg, 1940), ME= √∑d2/2n where d2 is the sum of the squared differences between the two mean values, and n is the number of double measurements. Inter-examiner reliability of identifying cephalometric landmarks was measured using Cronbach’s alpha reliability coefficient.

**Statistical Analysis:**
Statistical analysis was performed with SPSS 16.0 (Statistical Package for Scientific Studies) for Windows. Significance level was set at P ≤ 0.05. McNemar's test was used to study the association between new and routinely used methods assessing sagittal jaw relation. Kappa statistic was used to measure the reliability of different cephalometric methods used for assessment of jaw bases relationship. Kappa values can be interpreted as follows: poor (<0.2), fair (0.21 – 0.4), moderate (0.41 – 0.6), good (0.61 – 0.8) and very good (0.81 – 1.00).

**Result:**
The method errors for linear and angular measurement were not statistically significant, and did not exceed 0.5 mm and 0.8° respectively. The results showed very good inter-examiner reliability (Alpha range: 0.976 – 0.999). Cronbach’s alpha reliability coefficient normally ranged between 0 and 1. The closer Cronbach’s alpha coefficient is to 1, the higher the reliability. An alpha of 0.8 is probably a reasonable goal.

There was a statistically significant association between the new and routinely used methods as regards each Class. The least statistically significant value occurred in Wits appraisal regarding skeletal Class I and skeletal Class II subjects followed by ANB angle in the same skeletal Classes (Table I).

**Table 1:** The significant value of McNemar's test for the association between new and routinely used methods.

<table>
<thead>
<tr>
<th>Skeletal Class</th>
<th>NO. of patient in two or total agreement</th>
<th>Method used</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class I</td>
<td>103</td>
<td>Wits</td>
<td>0.009*</td>
</tr>
<tr>
<td></td>
<td></td>
<td>A-B diff (NV)</td>
<td>&lt;0.001*</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ANB</td>
<td>0.001*</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Dentoskeletal overjet</td>
<td>&lt;0.001*</td>
</tr>
<tr>
<td>Class II</td>
<td>91</td>
<td>Wits</td>
<td>0.003*</td>
</tr>
<tr>
<td></td>
<td></td>
<td>A-B diff (NV)</td>
<td>&lt;0.001*</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ANB</td>
<td>0.001*</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Dentoskeletal overjet</td>
<td>&lt;0.001*</td>
</tr>
<tr>
<td>Class III</td>
<td>56</td>
<td>Wits</td>
<td>&lt;0.001*</td>
</tr>
<tr>
<td></td>
<td></td>
<td>A-B diff (NV)</td>
<td>&lt;0.001*</td>
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<tr>
<td></td>
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<td>ANB</td>
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<td></td>
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<td>&lt;0.001*</td>
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</table>

*: Significant at P ≤ 0.05

Regarding the reliability of routinely and the new methods in assessment of anteroposterior jaw relationship using (Two or total agreement), results of Kappa statistical analysis showed that Wits appraisal showed moderate agreement (Kappa = 0.595) with (Two or total agreement). ANB method showed good agreement (Kappa = 0.655) with (Two or total agreement). A-B diff (NV) method showed very good agreement (Kappa = 0.832) with (Two or total agreement). All these agreements were statistically significant. The new measurement showed very good agreement (Kappa = 0.839) with (Two or total agreement). This agreement was statistically significant. So, the most reliable method in relation to two or total agreement was the new method, followed by A- B diff (NV) then ANB. Wits appraisal showed the lowest reliability.

**Discussion:**
An accurate anteroposterior measurement of jaw base relationships is important in orthodontic diagnosis and treatment planning. In cephalometrics, both angular and linear measurements have been proposed to analyze sagittal jaw base relationship. The first widely used method; ANB angle (Riedel, 1952), used to determine the anteroposterior maxillomandibular relationship; always vary according to the inclination and extension of the
Dentoalveolar compensation can be defined as a system, which attempts to maintain normal interarch relationships under varying jaw relationships (Solow, 1980; Ishikawa et al., 2000; Soliman et al., 2009). The differences in the interarch relationships of subjects with Class I, II, and III malocclusions are not directly due to differences in skeletal morphology, but to the fact that in the Class I group, in contrast to Class II and III subjects, the variation in jaw relationship has been compensated for by the dentoalveolar compensatory mechanism. Therefore dentoalveolar components may compensate for skeletal discrepancies in anteroposterior dimension to a great extent.

Overjet is an important measurement in study cast analysis. It has been one of the parameters used to investigate the sagittal relationship of the upper and lower dental arch. The cause of an increased or negative overjet could be skeletal, dental, or a combination of both. In adolescents beyond the growth spurt, when deciding on orthodontic or surgical intervention, in addition to the facial profile, overjet is an important guideline. Generally when the overjet is greater than 10mm, surgery is a more indicated treatment (Proffit et al., 1992). However, overjet is not always a reliable measure of the jaw relationship in the sagittal plane, especially in subjects with Class III malocclusions (Iwasaki et al., 2002). Although overjet is not a good predictor of skeletal relationships in the sagittal plane, but in Class II division 1 malocclusion subjects, however, overjet is a significant predictor; as a results of this, for accurate determination of jaw-base relationship, cephalometric analysis is necessary because two malocclusions may often appear alike when observing just an overjet but careful analysis could show a lot of differences (Zupancic et al., 2008).

In this study based on population sample, 103 subjects were classified as skeletal Class I, 91 subjects as skeletal Class II, and 56 subjects were classified as skeletal Class III according to the two or total agreement of the three documented method, the degree of association between this agreement and each method separately indicated that the least statistically significant value occurred in Wits regarding skeletal Class I and skeletal Class II subjects followed by ANB angle in the same skeletal classes, and statistical analysis showed that the most reliable method in relation to two or total agreement was the new method, followed by A - B diff (NV) then ANB. Wits appraisal showed the lowest reliability.

The general advantages of this method are; first, in cases where it was difficult to identify the most protruded tooth or even the upper or lower incisor points; any closer two points were taken as the measured distance between them (the overjet) is the compensating factor in this method; second, precise identification of the nasion point is not important as any small deviation in anteroposterior or vertical direction maintain the final skeletal class as it is because the final measurement depend on the difference between two measurements related to the same point, so any deviation that may cause increase in one measurement will result in decreasing the other measurement, making the difference in between both more or less within the range of the actual skeletal Class.

The advantages of the new method in assessment of anteroposterior jaw-base relationship over the ANB angle methods are;

1. It is a linear measurement that has distinct advantages over angular ones in that there are fewer variables affecting its accuracy.

2. Improper identification of the nasion point in the vertical direction will not affect the final assessment in this measurement; While in ANB angle, the nasion point is the head of the angle that any deviation in its position would directly and principally affect the ANB angle (Taylor, 1969).

The advantages of the new method over Wits appraisal are;

1. It depends on landmarks that are easy to identify and are routinely used in all cephalometric analysis.

2. Any inclination in the functional occlusal plane will not affect the final reading as the reference is not a line but it is a point that not affected by dental occlusion.
Generally; the new method put into consideration the following:
1- The cranial base.
2- Both maxillary and mandibular base.
3- Dentoalveolar compensation.
4- Overjet which is the most important clinical factor in assessing sagittal jaw relation.

Due to easy identification and minimal affection of the new method by tracing errors, in addition to its high reliability in relation to the commonly used methods in orthodontic literature. Dentoskeletal overjet could be used for better assessment of sagittal jaw relation which is an important issue in orthodontic diagnosis and treatment planning.

**Conclusion:**

1. A new linear measurement is developed as a diagnostic aid to evaluate the sagittal jaw relationship more consistently.
2. Previously established measurements for assessing the sagittal jaw relationship could often be inaccurate when taken separately.
3. White Yemeni subjects were classified as skeletal Class I when this measurement between -1 to +2.5mm, skeletal Class II when this measurement is more than 2.5mm, and skeletal Class III when it is less than -1mm.

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**REFERENCES**


