

# Classification of occlusion reconsidered

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**SUMMARY** Katz's quantitative modification of Angle's occlusion classification has been found to have a high intra- and inter-examiner agreement among orthodontists. In the present study an attempt was made to introduce a 'combined' system comprising Katz's modification and overjet/overbite millimetric measurements in order to attain a more meaningful and complete classification of malocclusion than is presently available. A group of 32 raters (16 orthodontists and 16 senior-year students) examined 14 study models twice, with an interval of at least 1 month between examinations. In total,  $448 \times 2$  determinations were performed. The percentage agreement of the Angle, the modified and the 'combined' systems, as well as the performance of the orthodontists versus the students were compared using the paired *t*-test.

The percentage agreement obtained by both orthodontists and students was highest for Katz's modification and lowest for Angle's method. The overjet/overbite measurements affected the agreement in Katz's modified technique. The orthodontists surpassed the students with respect to Angle's method ( $P = 0.025$ ), whereas no statistically significant difference existed between orthodontists and students regarding Katz's modification or the 'combined' system.

It is concluded that in view of the relatively low agreement in the 'combined' method, it cannot be recommended for clinical application. The Katz's modified method, on the other hand, may be a helpful supplement to Angle's classification.

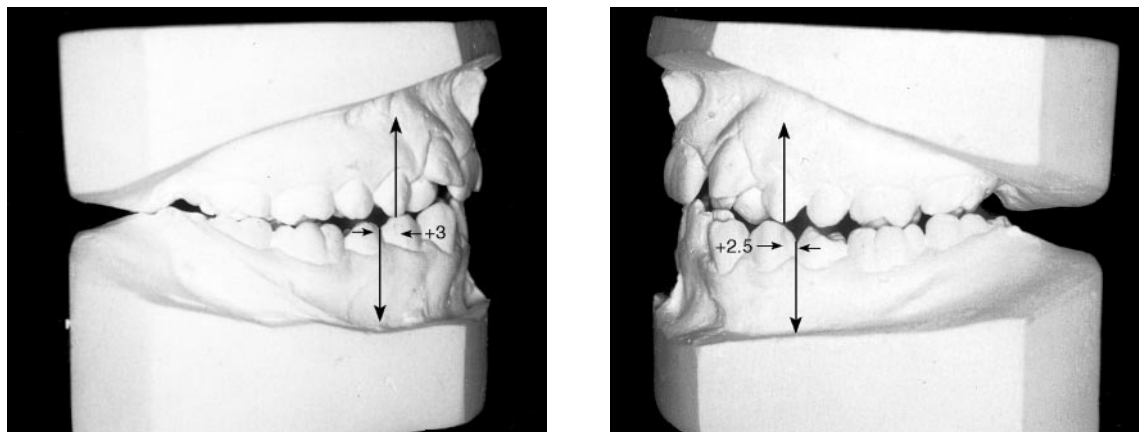
## Introduction

After a century of use, Angle's method still seems the most popular tool for classification of malocclusion, despite its well-known disadvantages (Katz *et al.*, 1990). Numerous studies have demonstrated the low reliability of both inter- and intra-examiner level of Angle's classification. Katz (1992a), among others, showed inter-examiner disagreement of 49 per cent among 270 orthodontists. Hans *et al.* (1994) noted the inadequacy of Angle's method when they were unable to classify approximately 7 per cent of a large ( $n = 4309$ ) sample of models in the Broadbent Bolton study. Baumrind *et al.* (1996) applied Angle's classification in their study on whether to extract in orthodontic treatment and found 28–33 per cent disagreement among the five participating orthodontists. Du *et al.* (1998)

demonstrated Angle's classification to produce the lowest intra- and inter-examiner reliability.

Over the years several alternatives have been suggested, such as the British method of overjet and overbite assessment (Williams and Stephens, 1992) and the quantitative technique proposed by Katz (1992b). Both systems proved to be more amenable to reproduction than Angle's classification (Williams and Stephens, 1992; Du *et al.*, 1998). However, these two methods seem to deal with only a partial description of the malocclusion, the British method relating to the anterior dentition and Katz's modification focusing on the buccal occlusion.

It was assumed that the quantitative Katz method in combination with overjet/overbite measurements might produce a higher percentage agreement than Angle's classification. At the



**Figure 1** Right and left view of case 6. Note the landmarks (mid-cusp of the upper first premolar and the distal embrasure of the lower first premolar) utilized in the Katz classification for the permanent dentition.

same time, such a 'combined' system might produce more meaningful data than either of the two former methods alone.

The purpose of this study was (a) to compare the percentage agreement of the 'combined' system with that of Angle's and Katz's methods, and (b) to ascertain whether the 'combined' system might prove more suitable than the Angle or Katz classification for teaching purposes.

### Materials and methods

A pilot study was conducted and its results indicated that for a significant difference between the Angle and the Katz methods to be found, at least 313 repeated examinations would have to be carried out where  $\alpha = 0.05$  and power = 0.80.

### Raters

Sixteen orthodontists and 16 senior-year dental students were enrolled in the study as raters.

It was assumed that they were familiar with both the Angle classification and the overjet/overbite millimetric measurement technique; thus, instructions regarding the application of these methods were not deemed necessary. For the Katz modification, written instructions based on his original paper (Katz, 1992b) were distributed together with the study models.

### Materials

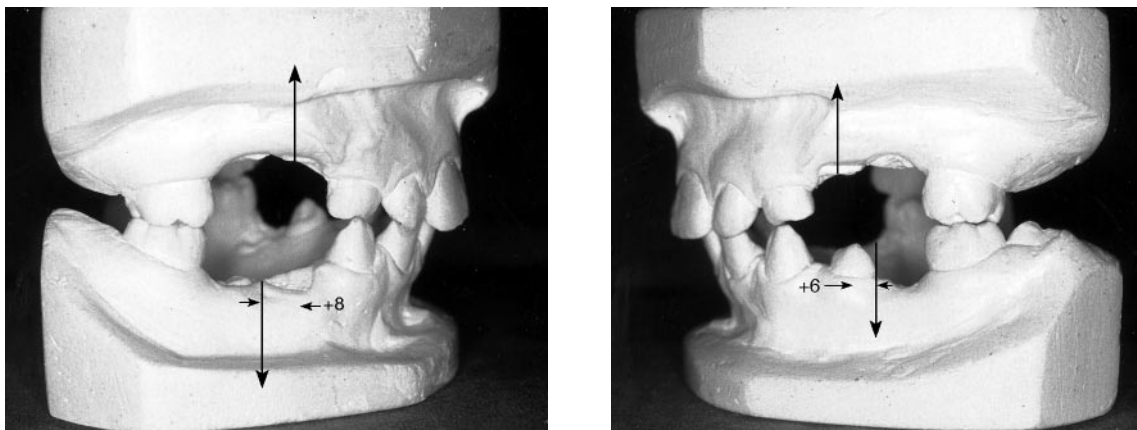
Fourteen sets of study models of different orthodontic patients were chosen at random. Each set was examined twice by the 32 raters with at least a 1-month interval between examinations. The total number of examinations thus amounted to  $448 \times 2$ .

### Methods

Three methods of occlusion classification were applied: (a) the Angle's classification; (b) Katz's modified method; and (c) a 'combined' system consisting of Katz's method plus millimetric measurements of overjet/overbite.

According to Katz (1992b) Class I is defined as an exact fit between the mid-cusp of the most anterior upper premolar and the embrasure created by the distal contact of the most anterior lower premolar. This 'ideal' relationship has been designated by Katz as 0, while a plus (+) sign indicates a Class II direction, and a minus (-) sign points to a Class III tendency (Figure 1). The same rules are applicable to the first deciduous molar in the mixed or deciduous dentition (Figure 2). Each side of the dentition is evaluated separately.

Overjet and overbite were measured using a small millimetric ruler, which was placed parallel or perpendicular to the occlusal plane.



**Figure 2** Right and left view of case 9. Note the landmarks utilized in the Katz classification for the mixed dentition (deciduous first molars are substituted for permanent premolars).

Agreement was defined as follows: two determinations of the Angle method are identical at both time points, or a difference of not more than 1 mm is established in repeated measurements in both the modified method and the 'combined' system.

#### *Statistical analysis*

The percentage agreement obtained for each of the three methods was calculated for each model. The results were compared applying the paired *t*-test. A significance level of  $\alpha = 0.05$  was used. In addition, the kappa index for the intra-rater variation between the two determinations for each model was computed. Kappa values of 0.4–0.75 indicate fair to good agreement (Abramson, 1990).

#### **Results**

The fluctuations in the percentage agreement among the three methods are presented in Table 1. Ranking the three classification techniques according to their percentage agreement yielded the following sequence, in descending order: Katz's modified method, the 'combined' system, Angle's classification (Table 2). This grading sequence was the same for both qualified orthodontists and senior-year students.

In the combination of overjet/overbite measurements plus Katz's quantitative method, the percentage agreement was significantly reduced.

With regard to the degree of professional expertise, the level of performance of the students was below that of the orthodontists when applying the Angle method, the difference being statistically significant (Table 2). On the other hand, there was no statistically significant difference between the two groups for either Katz's or the 'combined' method (Table 2). The kappa values for Angle's and Katz's methods indicated fair (0.47) and good (0.63) agreement, respectively.


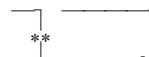




#### **Discussion**

In spite of the ongoing research (Case, 1905; Dewey, 1935; Dockrell, 1952; Van Kirk and Pennell, 1959; Grainger, 1960–1961; Ackerman and Proffit, 1969; Summers, 1971; Shaw *et al.*, 1991) to develop a comprehensive system, Angle's method still seems the most popular classification tool in dentistry. The fact that it relies on subjective judgement of the operator accounts, in all probability, for most of the inconsistencies inherent in the method. Even experienced orthodontists err in classifying occlusion according to Angle, as has already been indicated by other investigators (Katz,

**Table 1** Percentage agreement for each model and the three classification methods as obtained by orthodontists and students.

Model	Orthodontists			Students		
	Angle	Katz	Combined	Angle	Katz	Combined
1	69.0	75.0	50.0	50.0	69.0	69.0
2	69.0	87.5	69.0	75.0	87.5	69.0
3	62.5	87.5	75.0	62.5	69.0	50.0
4	87.5	69.0	44.0	31.5	69.0	62.5
5	69.0	81.5	69.0	44.0	94.0	62.5
6	37.5	81.5	69.0	31.5	75.0	69.0
7	56.5	81.5	69.0	56.5	62.5	44.0
8	37.5	62.5	62.5	44.0	87.5	87.5
9	44.0	44.0	37.5	37.5	31.5	31.5
10	75.0	87.5	75.0	44.0	75.0	50.0
11	87.5	94.0	81.5	62.5	81.5	69.0
12	75.0	62.5	56.5	62.5	69.0	56.5
13	56.5	62.5	56.5	50.0	50.0	44.0
14	62.5	100.0	94.0	69.0	81.5	69.0

**Table 2** Percentage agreement for each of the three methods of occlusion classification tested.

Method	Raters		Orthodontists versus students
	Orthodontists ( <i>n</i> = 16)	Students ( <i>n</i> = 16)	
Angles	63.5 	51.5 	*
Katz	76.9 	71.6 	NS
‘Combined’	64.7 	59.4 	NS

\* $P < 0.05$ ; \*\* $P < 0.001$ ; NS = not significant.

1992a; Gravely and Johnson, 1974; Baumrind *et al.*, 1996; Du *et al.*, 1998). The significantly lower percentage agreement attained by the senior-year dental students as compared with the qualified orthodontists in the present study (Table 2) is, therefore, not an unexpected phenomenon. In fact, with regard to the present authors' teaching experience, the difficulties with which dental hygienists and dental students struggle when attempting to apply the Angle method are continually encountered.

However, a closer analysis of the results obtained in this study reveals that in a number of

cases the Angle method produced a similarly low percentage agreement for orthodontists and students alike. To substantiate this claim, the reader is referred to case 6 (Figure 1, Table 1), which demonstrates the limited applicability of Angle's method. This same case, when classified by the modified Katz method or the 'combined' technique, attained a remarkably higher percentage agreement for both the orthodontists and the students.

The modified quantitative method of Katz (1992b) overcomes the 'judgement' problem by introducing a continuous measurement system.

The latter helps in solving one of the basic difficulties of classification, namely that a clear-cut separation of biological phenomena is often unattainable due to the fact that most properties vary continuously (Bright Wilson, 1952). The same rationale underlies Gottlieb's (1996, 1997) contention regarding gradations between Angle's classes.

The percentage agreement of Katz's technique proved superior to that of the classical Angle classification, a conclusion that has also been reached by Du *et al.* (1998). The reliability of Katz's modified method as demonstrated by the high kappa value and percentage agreement was a favourable finding in view of (a) the lack of experience of both orthodontists and students with this particular method, (b) the strict conditions adhered to (not more than 1 mm difference between repeated bilateral measurements), and (c) the hand-held position of the models, which can easily affect millimetric measurements.

Nevertheless, Katz's modified method does not improve reliability unrestrictedly. Thus, for example, the low percentage agreement obtained using Angle's classification as shown in case 9 (Figure 2, Table 1) deteriorated even further with Katz's method or the 'combined' system. The discrepant results regarding this particular case are probably due to severely submerged primary molars, which impeded measurement of the sagittal relationships in this patient. This case illustrates clearly one of the drawbacks of Katz's modified method, namely its reference to an extremely restricted segment of the dentition. Thus, although recognizing the advantage of the modified method, it is still not the ultimate technique for occlusal determinations; at most, it can serve as a supplementary measure to the classical Angle method.

The rationale of combining Katz's quantitative method with the overjet/overbite measurements was that the numeric addition would allow a more valid classification. The statistical evaluation of this 'combined' technique indicated no difference between orthodontists and students, as was also noted for the modified method. However, the percentage agreement when using the 'combined' technique proved to be significantly lower than that obtained with the modified method, but similar to that of Angle's technique

(Table 2). The discrepancy between the two quantitative methods should be sought in the multiple measurements demanded by the 'combined' technique (right and left buccal segments, overjet, and overbite), thereby increasing the possibility of measurement error. Thus, reinforcement of Katz's modified method by overjet/overbite measurement does not seem a feasible venture.

## Conclusions

1. Based on the results of this intra-observer study, the use of Katz's modified method might be justified from the point of *agreement*.
2. Katz's modified quantitative method might serve as a useful *supplement* to the classical Angle method.
3. The features incorporated in Katz's modified method make it suitable for teaching purposes, albeit only as a classification adjunct.
4. The 'combined' technique applied in this study does not have an advantage over either the classical Angle classification or Katz's modified technique.

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