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Research Article

THE RELIABILITY OF THE BOLTON RATIO WHEN APPLIED TO THE INDONESIAN POPULATION

JOKO KUSNOTO*

Department of Orthodontics, Faculty of Dentistry, Trisakti University, Jl. Kyai Tapa No. 260, Jakarta 11440, Indonesia.
Email: j_kusno@hotmail.com

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ABSTRACT

Objective: The objective of this study is to determine whether Bolton ratio can be applied clinically to the Indonesian population and to determine a more suitable Bolton ratio for the Indonesian population.

Methods: This study was conducted on 120 readily available study models of treated cases comprising 37 males and 83 females. Two investigators separately measured the mesiodistal crown width of maxillary and mandibular tooth on each study model using sliding calipers. According to Bolton's method, the overall and anterior ratios from each sample were calculated and the mean was generated. Using Student's t-test with a 95% confidence interval, the investigators compared whether there is a significant difference between the ratio from Bolton's samples and the ratio from the Indonesian samples.

Results: The result of this study showed that, for Indonesian samples, the overall ratio is 89.7±2.05, while the anterior ratio is 76.4±2.76. Student's t-test showed that there is a statistically significant difference ($p<0.05$) between the results of this study and that of Bolton's study for both the anterior and overall ratios.

Conclusion: It can be concluded that there is a difference between Indonesian population and Caucasian population in tooth size and Bolton ratio value. Therefore, original Bolton ratio value cannot be used as an accurate diagnostic tool for Indonesian population.

Keywords: Bolton ratio, Anterior ratio, Overall ratio, Indonesian population.

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INTRODUCTION

In orthodontics, besides good teeth alignment, normal facial morphology and good occlusion is also essential. Malocclusion can lead to abnormal function of the stomatognathic complex. A good relationship between the maxillary teeth and the mandibular teeth is only possible when the mesiodistal width of the maxillary and the mandibular teeth in both jaws matches. If the mesiodistal crown diameter of the opposing teeth does not correspond, it will lead to a defective occlusion, which in turn may cause problems such as temporomandibular disorder [1-3].

During the orthodontic treatment planning process, it is necessary for a clinician to gather complete information about the case. The information becomes available through a number of ways, such as proper general and dental health history elucidation, clinical examinations, study models, and cephalometric analyses. One of the most important utilizations of study model analyses is to determine whether upper dentition will occlude satisfactorily with the lower dentition, this analysis is widely known as Bolton's ratio [1,4]. In order for the maxillary teeth to fit well with the mandibular teeth, there must be a definite proportionality of tooth size; the sum of the widths of the mandibular teeth must be somewhat smaller than the sum of the widths of the maxillary teeth, because the mandibular teeth are aligned along an arch that is smaller than that of the maxillary teeth [5].

The study by Dr. Wyne Bolton's titled, "regarding disharmony in tooth size and its relation to the analysis and treatment of malocclusion" determines the ratio between the mesiodistal width of all teeth on the maxilla and the mandible, he divided the ratio into anterior and overall ratio. Bolton states that the ratio between the maxilla and the mandible has to be ideal to get an ideal occlusion. However, Bolton did not consider or exemplify the possibility of applying the index for other races, while it is a common knowledge that, in diagnosing medical problem, race also should be taken into consideration because it may play a role as a major determinant. Theoretically, the Bolton ratio might be less accurate when applied to other races, because some variation of tooth size exists among different races [5-7].

The mesiodistal width has been frequently used as a general indicator of tooth size [8]. Measuring tooth size has been carried out with one of these three basic instruments: sliding calipers, engineer dividers and a millimeter ruler, and holes punched on a card where the distances are measured with millimeter ruler. Bolton used the sliding caliper which provides higher accuracy rates. Hunter and Priest also found that sliding calipers achieve more accurate measurements and results. The sliding calipers demonstrated a higher frequency of significantly correlated repeated measurement and thus may be somewhat more reliable for this analysis than the needle-pointed dividers [5,9].

The objective of this study is to determine whether Bolton ratio can be applied clinically to the Indonesian population and to determine a more suitable ratio for the Indonesian population.

MATERIALS AND METHODS

Materials

1. 120 readily available casts of treated cases with no identifier were taken from a private orthodontic practice. The samples consist of 37 males and 83 females, with inclusion criteria as follows:
   - Sample is included in Indonesian ethnic groups
   - Sample is in permanent dentition stage
   - Upper and lower incisors, cuspid, bicuspid, and first molar are complete, with clearly visible proximal margin, and in proper position

- Incisors, cuspid, bicuspid, and first molar should have no morphological anomaly, proximal caries, attrition, erosion, abrasion, restoration on proximal surface, and the orthodontic treatment should not involve any interproximal reduction procedure
- Acceptable profile with ideal Angle Class I occlusion.

2. Sliding calipers (Masel, USA)
3. Personal computer.

Methods

This is a cross-sectional observational analytic study. The protocol of this study was reviewed and approved by the Ethical Committee of Faculty of Dentistry, Trisakti University. In this study, sliding calipers with 0.1 mm accuracy were used to measure mesiodistal crown width on the study models made from orthodontic stone. Separately, 2 investigators performed the measurement, if there is a measurement discrepancy more than 2 mm for 1 arch between the 2 investigators, the 3rd investigator will measure the study model. The Bolton analysis procedure was performed as follows:

1. The mesiodistal widths of 12 maxillary teeth from the right 1st molar to the left 1st molar were measured and compared with the sum derived by the same procedure carried out on 12 mandibular teeth (Fig. 1). The ratio between the two is the percentage relationship of the length of the mandibular arch to the length of the maxillary arch which is referred as the "overall ratio"
2. The same method was used in setting up a ratio between the maxillary and the mandibular anterior teeth (Fig. 2). The ratio between the two is the percentage relationship of the anterior length of the mandibular arch to the anterior length of the maxillary arch which is referred as the "anterior ratio"

According to Bolton's method, the overall and anterior ratio from the samples can be calculated. After the overall ratio and the anterior ratio from all the study models were calculated, the mean of the overall ratio and the anterior ratio from those samples were generated. Then, using Student's t-test with a 95% confidence interval, the investigators can compare whether there is a significant difference between the ratio from Bolton's samples and the ratio from the Indonesian samples.

RESULTS

The result of this study showed that, for Indonesian samples, the overall ratio is 89.7±2.05, while the anterior ratio is 76.4±2.76. Those figures were then statistically tested against Bolton's ratio using Student's t-test with 95% confidence interval (α=0.05). The result showed that there is a statistically significant difference ($p<0.05$) between the results of this study and that of Bolton's study for both the anterior and overall ratios (Table 1).

DISCUSSION

Humankind can be divided into three major race categories for research purposes due to their physical characteristics as Caucasoid, Negroid, and Mongoloid. The Indonesian people would fall under the Mongoloid race [11]. A study by Keene stated that the mean of the mesiodistal width of 28 teeth on the maxilla and the mandible (excluded 3rd molar) on male Negroid (234.26 mm) is 8.4% larger than that of the male Caucasian (216.96 mm) [12]. The dental crown of Eskimos is larger than those of European Caucasians, but at the same time, the 3rd molars of Eskimos show a tendency toward reduction in crown size [9]. The mesiodistal crown diameter of North American Caucasian is different from the mesiodistal crown diameter of Javanese which is the largest tribe in Indonesia [13].

A suitable occlusion was influenced by maxillary and mandibular tooth size, the mesiodistal width of the crown diameter which is not fit will cause the malocclusion [1]. In this study, the investigators compared the mesiodistal width of the crown diameter ratio between maxillary and mandibular permanent teeth in Indonesian samples with Bolton's samples. According to the statistical analysis with a 95% confidence interval (α=0.05), there is a significant difference in both the anterior and the overall ratios.

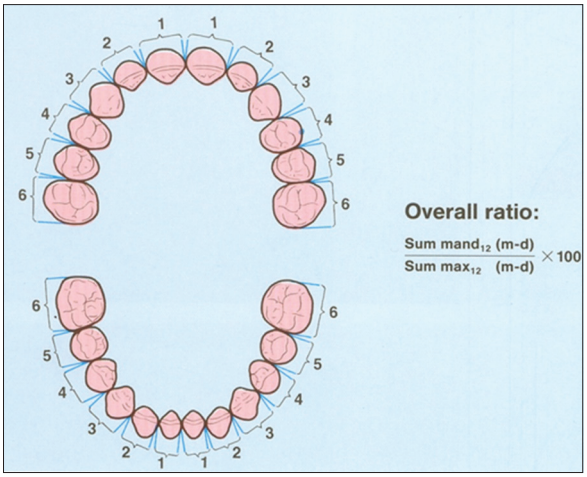

Fig. 1: Overall ratio [10]

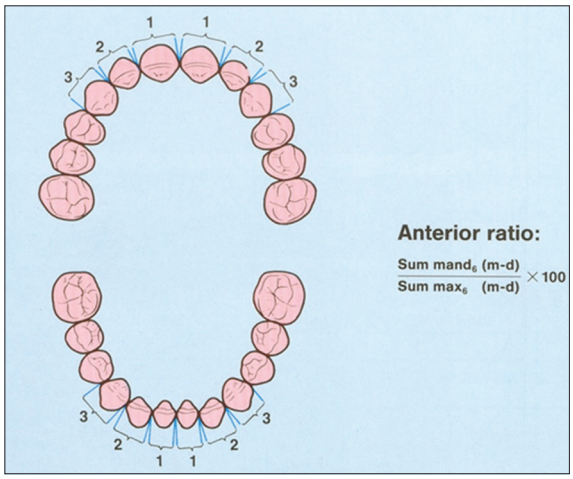

Fig. 2: Anterior ratio [10]

Table 1: Student's t-test between Indonesian samples and Bolton samples

	Indonesian samples	Bolton samples	t
Anterior ratio % (mean±SD)	76.4±2.76	77.2±0.22	1.995*
Overall ratio % (mean±SD)	89.7±2.05	91.3±0.26	4.907*

*($p<0.05$), SD: Standard deviation

This study also compared the mesiodistal width of the crown diameter ratio between males and females based on the fact that, in a study of tooth size, males and females should be reviewed separately whenever possible as mentioned in a study [9]. In a preliminary study, statistical analysis with a 95% confidence interval (α=0.05) found that there is no significant difference between male and female mesiodistal width of the crown diameter ratio in the Indonesian samples, so the investigators decided not to differentiate the samples' gender.

CONCLUSIONS

Based on this study, it can be concluded that there is a difference between Indonesian population and Caucasian population in tooth size and Bolton ratio value. Therefore, original Bolton ratio value cannot be used as an accurate diagnostic tool for Indonesian population. For

Indonesian population, the Bolton tooth size ratio value of 89.7±2.05 for overall ratio and 76.4±2.76 for anterior ratio is more suitable.

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