Research

Bolton discrepancy among patients with anterior open bite malocclusion

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ABSTRACT

Introduction: Several investigators studied Bolton's discrepancy in relation to different types of malocclusions, but no studies were found investigating Bolton's discrepancy in open bite cases. The aim of the present study was mainly to determine tooth size discrepancy in a sample of orthodontic patients with open bite malocclusion and to test any correlation between open bite and anterior, posterior, and overall ratios.
Method: Eighty-four study models of patients with open bite (42 females and 42 males) and 33 study models of ideal occlusion as control (18 females and 15 males) were selected. The mesiodistal width of upper and lower teeth, excluding second and third molars, was measured using a digital calliper, and the anterior, posterior, and overall ratios were calculated.
Results: The anterior, posterior, and overall ratios for the open bite Saudi sample was 77.14 (SD 3.27), 104.5 (SD 4.80), and 90.46 (SD 3.90), respectively. The Student's *t* test showed no significant difference between the open bite and control groups in all ratios. The Pearson correlation coefficient showed no significant correlations between open bite and anterior ratio, total ratio, and posterior ratio.
Conclusion: Even though the anterior, posterior, and overall ratios are not significantly different from control or Bolton's ratios, open bite cases require a close evaluation of tooth size discrepancy in all anterior, posterior, and total ratios to achieve ideal occlusion.

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1. Introduction

In 1958, Bolton [1] developed an analysis to establish the normal anterior and overall ratios of the mesiodistal widths of the maxillary and mandibular teeth. Bolton [1] hypothesised that establishing a mathematical relationship between the total length of maxillary and mandibular dental arches of an ideal occlusion would give orthodontists a perfect diagnostic tool to assist in the diagnosis of discrepancies in teeth of any size. This method, now known as Bolton's analysis, is a widely used tool in orthodontic diagnosis. Proper mediodistal proportion between maxillary and mandibular teeth is important to ensure proper overbite, overjet, and maxillary and mandibular teeth interdigitations at the end of orthodontic treatment [2–5]. One of its advantages is allowing the orthodontist to predict, ahead of time and without using diagnostic setup, the expected outcomes of the treatment and the need of tooth reduction or addition.

Studying the variability of tooth size and tooth size discrepancy is important to understand the applicability and the validity of Bolton's analysis on different races. Several studies have investigated Bolton's anterior and overall ratio in different racial populations. Oyeyemi et al. [6] studied 400 cases and found that Bolton's ratios and prediction tables are not applicable to the Nigerian population. Kachoei et al. [7] showed no significant differences in the intermaxillary tooth size relation between Iranians and Bolton's sample. When applying Bolton's tooth size discrepancy analysis on 55 cases of normal occlusion, Nourallaha et al. [8] found that the overall and anterior ratios' values and the degree of variation were similar to Bolton's values. Al-Omari et al. [9] also found similar results when studying 367 Jordanian schoolchildren.

Several investigators studied Bolton's discrepancy in relation to different types of malocclusions [2,3,6,10,11]. Oktay and Ulukaya [12] found no significant differences among Class I, Class II division (div) 1 and div 2, and Class III malocclusions in Bolton's anterior ratio but found a significant difference in the overall and posterior ratios, whereas Basaran and colleagues [10] found no significant differences in any of Bolton's ratios related to the same types of malocclusion. Al-Sulimani and Afify [13] also showed no significant differences in a study of 160 different types of malocclusion. Asiry

and Hashim [14] studied 60 cases of Class II div 1 malocclusion and found no significant difference when compared with Class I normal occlusion cases. It is notable that most of the studied cases of malocclusion were Class I, Class II div 1 and div 2, or Class III, which were studying the relationship between tooth size and malocclusions in the anteroposterior plane. The study of the association between tooth size discrepancy and malocclusion in the vertical plane, represented in overbite, is not widely studied in the literature. Bolton [1], in his original study, analyzed 55 cases of excellent occlusions and found no relation between the mesiodistal width of the teeth and the degree of overbite. Bolton [1] measured the positive overbite in ideal occlusion, represented in the amount of maxillary anterior teeth covering the mandibular anterior teeth. Alam and Lida [15] also studied the tooth size discrepancy in relation to normal, increased, and decreased overbite and evaluated decreased bite less than 2 mm in different types of malocclusion; neither study evaluated negative overbite. In fact, no published study was found to assess tooth size discrepancy in open bite cases specifically.

$$\text{Anterior Ratio} = \frac{\text{Sum of mesiodistal widths of lower anterior teeth } 3-3}{\text{Sum of mesiodistal widths of upper anterior teeth } 3-3} \times 100$$

$$\text{Posterior Ratio} = \frac{\text{Sum of mesiodistal widths of lower posterior teeth } 4-6}{\text{Sum of mesiodistal widths of upper posterior teeth } 4-6} \times 100$$

$$\text{Overall Ratio} = \frac{\text{Sum of mesiodistal widths of lower teeth } 6-6}{\text{Sum of mesiodistal widths of upper teeth } 6-6} \times 100$$

The difficulties that orthodontists face when finishing open bite cases is produced by several factors, and it is important to study the possibility that the discrepancy between the mesiodistal width of maxillary and mandibular teeth is one of these factors. Thus, the main objectives of this study were (1) to determine tooth size discrepancy in a sample of Saudi that mainly have open bite malocclusion; (2) to test any correlation between open bite and anterior, posterior, and overall ratios; (3) to evaluate any sexual dimorphism in the anterior, posterior, and overall ratios in cases of open bite malocclusion; and (4) to investigate any racial differences between Bolton's ratio and other studies in the literature.

2. Methodology

Eighty-four study models of patients with open bite malocclusion were randomly selected from the King Abdulaziz University Faculty of Dentistry in City of Jeddah for this study. The selection criteria of the casts were (1) permanent dentition erupted, including only first molars; (2) anterior open bite; (3) no tooth agenesis or extraction; and (4) no teeth with anomaly.

Thirty-three study models of ideal occlusion as a control also were selected using the selection criteria of (1) permanent dentition was erupted, including only first molars; (2) ideal overbite (2−3 mm) and overjet (1−2 mm); (3) ideal posterior interdigitation; and (4) no orthodontic treatment.

2.1. Study model measurements

The following dimensions of the study models were measured using a digital calliper connected to the computer. Readings were directly registered into the computer to ensure accuracy, including (1) mesiodistal width of upper and lower teeth in millimeters, excluding second and third molars; and (2) the anterior, posterior, and overall ratios were calculated as follows:

For determination of the errors associated with the measurements, 20 study models were randomly selected. The measurements were repeated in 4 weeks by the investigator. For intraexaminer errors of the measurement evaluation, Pearson's coefficient correlation and the standard error of the estimate were used.

2.2. Statistical analysis

Data were analyzed using the SPSS software package (SPSS for Windows version 18.0; SPSS Inc., Chicago, IL). Descriptive statistics of the sample were calculated using the mean values and standard deviations (SDs) of demographic data, mesiodistal widths of upper and lower teeth, and intermaxillary tooth size ratios.

The Student's t test was used to determine any differences in the means of the intermaxillary tooth size ratio between the open bite

Table 1
Comparison table showing minimum, maximum, means, SD, t value, and P value of overbite, anterior ratio, overall ratio, and posterior ratio in open bite and control groups

	Open bite			Control			t value	P
	Min	Max	M (SD)	Min	Max	M (SD)		
Overbite	−11	1	−3.64 (1.98)	0.10	2.30	0.97 (.67)	−13.54	0.000
Anterior ratio	69.94	86.73	77.14 (3.27)	71.53	81.6	76.97 (2.26)	0.322	0.748
Overall ratio	74.15	98.13	90.46 (3.90)	86.22	94.94	91.15 (1.95)	0.326	0.326
Posterior ratio	96.60	114.98	104.50 (4.80)	99.49	112.06	105.08 (3.08)	0.521	0.521

M, mean; Max, maximum; Min, minimum.