Tooth-Size Discrepancies in Patients Requiring Mandibular Advancement Surgery

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Purpose: Numerous studies have shown that tooth size is an important key to ideal occlusion. Bolton (Angle Orthod 28:13, 1958; 48:504, 1962) described a constant ratio between the widths of the upper and lower teeth that must be present to achieve an optimal occlusion. The purpose of this study was to determine the incidence of Bolton discrepancies in patients with Class II malocclusion scheduled for mandibular advancement surgery.

Patients and Methods: This study included 126 patients (40 male, 86 female) with Class II malocclusion who had at least a mandibular advancement as part of their surgical treatment. The mesiodistal widths of the 6 anterior maxillary and mandibular teeth were measured on preoperative models using a caliper. The measurements were used to compute the anterior Bolton ratio.

Results: Seventy-three of 126 patients (57.9%) were found to have an anterior Bolton ratio greater than the Bolton norm, indicating too much lower tooth mass compared with the upper mass or too little upper tooth mass compared with the lower mass.

Conclusion: Tooth-size discrepancies are common in patients requiring mandibular advancement surgery. This can make it difficult to advance the mandible into a solid Class I relation at the time of surgery. Bolton discrepancies should be considered when planning treatment with presurgical orthodontics. In addition, if necessary, the width of the lower incisors should be decreased or a space distal to the maxillary lateral incisors should be created to allow the establishment of a solid Class I canine occlusion at the time of surgery.

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According to the National Health and Nutrition Examination Survey III study, which evaluated approximately 7,400 children 6 to 11 years of age and more than 22,000 youths 12 to 17 years of age, 15% of the US population have an overjet greater than 4 mm and 33% have Class II occlusal discrepancies.[1] The same frequency for Class II malocclusions was found in Caucasians, African Americans, and Hispanics.[1] According to McNamara[2] and Lawrence et al,[3] 75% of Class II discrepancies are the result of mandibular retrognathia. Because Class II malocclusion is a problem with dental and skeletal components, tremendous effort and good communication between the surgeon and the orthodontist is required to achieve optimal results. Much attention has been paid to the skeletal correction of patients with Class II malocclusion but very little information exists concerning tooth-mass discrepancies in this group of patients. It should be obvious that the desired skeletal position cannot be attained unless the dental structures are arranged in a manner that will allow for better esthetics and a stable and favorable occlusal scheme.

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The human dentition has been studied and analyzed by several investigators since the early 20th century, when Black[4] described the specific anatomy for each tooth in the oral cavity and was one of the first to describe the average measurements of the teeth. Several studies have described the tooth-size discrepancies among the different Angle malocclusion groups, ethnic backgrounds, and genders.[5-10] There have been several publications since then to determine the ideal tooth-size ratios that must exist between the maxillary and mandibular arches to achieve proper intercuspation and adequate overjet and overbite of the anterior segments.[11] Bolton,[11,12] one of the first to do so, determined that a ratio of 77.2% between the upper and lower anterior teeth is ideal for proper overjet and overbite of the anterior segments. Araujo and Souki[5] later reported a greater prevalence of anterior tooth-size discrepancies in patients with Class I and III malocclusion than in those with Class II malocclusion. Neff[13] computed an anterior coefficient of 1.20 to 1.22 that coincides with a 20% overbite of the incisors, which would be considered ideal. Batool et al[9] were the only group to report a meaningfully larger mean anterior tooth ratio than Bolton in a sample of orthodontic patients with Class II malocclusion.

The authors have noticed that many patients presenting for mandibular advancement surgery cannot be advanced into a solid Class I canine relation without the lower incisors being brought into an end-to-end relation with the upper incisors or even into a frank under-jet relation (Fig 1). Only 1 study examined Bolton discrepancies in a sample of patients with Class II malocclusion scheduled for mandibular advancement surgery but the sample was very small (N = 20).[6] The purpose of this study was to determine anterior tooth-mass discrepancies in a large sample of patients scheduled for mandibular advancement.

FIGURE 1. *A*, Maxillary cast of a patient "ready for surgery" showing small lateral incisors. **(Fig 1 continued on next page.)**

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Patients and Methods

Data on patients scheduled for mandibular advancement from 2012 through 2014 at the Department of Oral and Maxillofacial Surgery of the University of Texas Health Science Center San Antonio (San Antonio, TX) who fulfilled the inclusion criteria were collected. Inclusion criteria were Angle Class II canine relation before surgery, mandibular retrusion assessed cephalometrically using an ANB angle larger than 4°, high-quality diagnostic models available, presence of all anterior teeth from canine to canine in the 2 arches (no missing anterior teeth), no severe mesiodistal tooth abrasion or occlusal attrition, and no tooth deformity (ie, peg lateral incisors). Patients who underwent concomitant temporomandibular joint procedures (disc repositioning or joint arthroplasty) or had a history of orthognathic surgery, trauma to the facial skeleton, or cleft lip or palate repair were excluded from the study.

Pretreatment study models obtained at the presurgical visit (within 1 to 2 weeks of surgery) were analyzed by measuring the mesiodistal widths of the upper and lower 6 anterior teeth with a manual Helios caliper accurate to 0.01 mm (Fig 2). All measurements were performed by the same individual. The teeth were measured at their largest diameter and the anterior ratio was computed according to the Bolton formula:

$$\text{sum of mandibular anterior 6 teeth divided by sum of maxillary anterior 6 teeth} \times 100$$

The error of the method was performed by re-measuring the casts of 5 randomly selected patients from the original sample. The measurements were repeated twice 1 week apart by the same individual.

The error of the method was determined by the Dahlberg formula.[14] The Dahlberg error does not distinguish between systematic and random errors; therefore, paired *t* test also was performed to assess the systematic error.

Results

One hundred twenty-six patients (40 male, 86 female) were selected based on the inclusion criteria. The mean anterior Bolton ratio for these patients was 77.9, which is very close to the Bolton ratio. The minimum anterior Bolton ratio calculated was 65.1 and the maximum ratio was 86.3 (standard deviation, 1.73). There were 73 patients (57.9% of total sample) with Bolton discrepancies greater than the Bolton mean ratio of 77.2 and 53 patients