

# Examining Tooth-size Discrepancies in Regard to Treatment, Treatment Planning and Completion

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**Abstract** Introduction: In orthodontic diagnosis and treatment planning it is an important goal to reach the best functional and esthetic results. However, during treatment planning the size of the teeth is a frequently ignored factor. The discrepancies of the mesiodistal widths of the teeth can be examined with the Bolton analysis. Our aim is to investigate whether the results described by Bolton are applicable to the population treated by us. Methods: At our clinic we examined the relative tooth size differences of the maxillary and mandibular teeth in 102 clinical patients (64 girls and 38 boys). During the study we formed groups based on gender and dental anomalies. Results: Our resultant measurements diverged from the results published by Bolton to some extent but did not show significant differences. Conclusions: As a conclusion, it can be stated that the diagnostic method developed by Bolton can be applied to the regional dento-alveolar values.

**Keywords** Bolton Analysis, Tooth-size Discrepancy, Extraction, Treatment Plan

## 1. Introduction

The task of orthodontic treatment is to look after the harmonic development of the face and the teeth.

Several factors can influence the success of the treatment. Apart from genetic factors, the extent of teeth movement, the position of the mandibles, the tendency of growth, anatomical and morphologic factors and the limitations of diagnosis and treatment plan.

For proper occlusion, for the space-less and uncrowded position of the teeth the relative ideal size of mandibular and maxillary teeth is important.

The relative tooth-size plays an important role in deciding the contact point between neighboring teeth. It occurs that after the orthodontic treatment when removing the orthodontic appliance we experience an increased overbite and an excessive overjet. In this case the patient is disturbed by seeing spaces between his teeth. Because tooth-size discrepancy can influence the final results and stability of the

orthodontic treatment, in order to reach perfect results exploring tooth-size discrepancies prior to the treatment is indispensable.<sup>1</sup>

## 2. Materials and Methods

Wayne A. Bolton examined the relative position of the mandibular and maxillary teeth in 1958. He examined the mesiodistal widths in patients with perfect occlusion and patients with orthodontic malocclusion.<sup>2</sup>

He stated the general ratio of the sum of tooth-widths of the 6 anterior mandibular and maxillary teeth is 77.2% (Table 1) according to Bolton's formula (Sum mandibular<sup>6</sup>/Sum maxillary<sup>6</sup>×100=anterior ratio (%). In case of the 12 permanent mandibular and maxillary teeth this ratio was 91.3% (Sum mandibular<sup>12</sup>/ Sum maxillary<sup>12</sup>×100=overall ratio (%) (Table 2). According to his studies tooth groups 1.7% (standard deviation) up or down from this value can be considered proportionate.

**Table 1.** Mean mesiodistal widths of upper front teeth and mean of lower teeth values according to Wayne A. Bolton (mm)

Upper	40	40.5	41	41.5	42	42.5	43	43.5
Lower	30.9	31.3	31.7	32	32.4	32.8	33.2	33.6
Upper	44	44.5	45	45.5	46	46.5	47	47.5
Lower	34	34.4	34.7	35.1	35.5	35.9	36.3	36.7
Upper	48	48.5	49	49.5	50	50.5	51	51.5
Lower	37.1	37.4	37.8	38.2	38.6	39	39.4	39.8
Upper	52	52.5	53	53.5	54	54.5	55	
Lower	40.1	40.5	40.9	41.3	41.7	42.1	42.5	

**Table 2.** Mean mesiodistal widths of the 12 upper teeth and mean of lower teeth widths (mm)

Upper	85	86	87	88	89	90	91	92
Lower	77.6	78.5	79.4	80.3	81.3	82.1	83.1	84
Upper	93	94	95	96	97	98	99	100
Lower	84.9	85.8	86.7	87.6	88.6	89.5	90.4	91.3
Upper	101	102	103	104	105	106	107	108
Lower	92.2	93.1	94	95	95.9	96.8	97.8	98.6
Upper	109	110						
Lower	99.5	100.4						

For frontal teeth: 77.2% ± 1.6% (75.5-78.9)

For overall dentition: 91.3% ± 1.9% (89.4%-93.2)

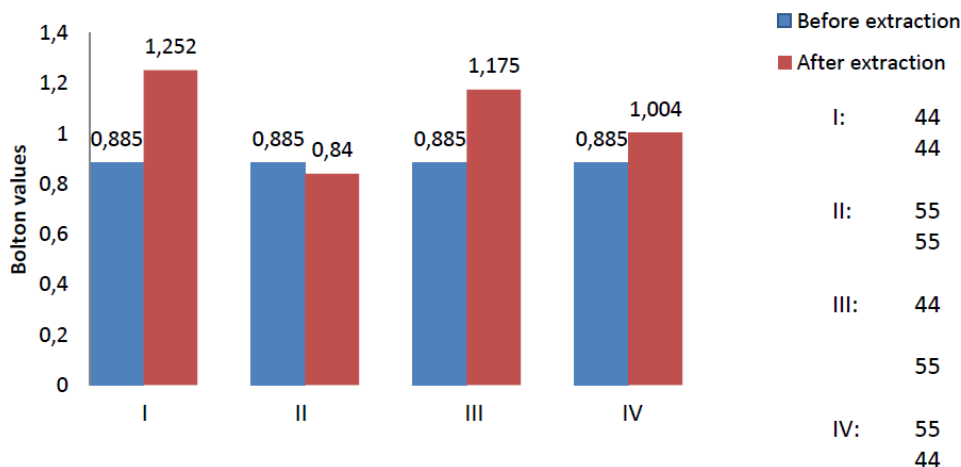


Figure 1. Effect of premolar extraction on tooth-size discrepancy

In Bolton’s discrepancy 'extra teeth' is experienced, so there are crowded teeth in the dental arch. In this case, if the discrepancy is not bigger than 2.5 mm in the mandible, stripping of the approximal surfaces can be performed. If the discrepancy is bigger than this, extraction can be performed. During treatment planning, we frequently face the dilemma whether to perform extraction, or which teeth to extract. The consequences of extraction in ideal dental arches have been studied (Figure 1).<sup>3</sup> Premolar extractions have been performed in pretreated dentition with no Bolton discrepancy in 4 different combinations. In the first group all first premolars, in the second group all second premolars, in the third group upper first and lower second premolars and in the fourth group upper second and lower first premolars were extracted. After the extractions tooth-size relations of the patients were examined again.

The highest number of tooth-size discrepancies was experienced after the extraction of the four first premolars. The smallest discrepancy was experienced after the extraction of the four second premolars. Because the mesiodistal width of the lower second premolars is bigger than the first premolars, it allows greater mesial movement for the lower molars, which results in the smallest tooth-size discrepancy. Consequently, it can be stated that with routinely performed extraction of the four first premolars we ourselves can cause tooth-size discrepancies, which can result in further difficulties at the end of the treatment.

The purpose of our study is to investigate whether Bolton values apply to the patients of the Dental and Dental Surgery Clinic of the University of Pécs, the population of the south Transdanubian region of Hungary.

At the Dental and Dental Surgery Clinic of the University of Pécs we examined the relative tooth-sizes of mandibular and maxillary teeth of 102 pretreated patients (64 girls and 38 boys, aged 14-20).

The participating patients were selected based on the following criteria:

- absence of dental crown or denture, absence of restoration

- absence of formal deviation, dental deformity (e.g. pin tooth)
- absence of mesiodistal and occlusal tooth abrasion
- there are permanent teeth from first molar to first molar
- good quality pretreated model
- absence of aplasia

The mesiodistal dimension of each tooth was measured with a digital calliper (with accuracy of 0.01 mm). From the resulting measurements we calculated with the Bolton formula

$$\text{overall ratio} = 100 \times (\Sigma_{\text{mand.6-6}} / \Sigma_{\text{max.6-6}})$$

$$\text{anterior ratio} = 100 \times (\Sigma_{\text{mand.3-3}} / \Sigma_{\text{max.3-3}})$$

Independent samples *t* test was used in order to decide if the ratio of the measured population is the same as in the research of Bolton.

### 3. Results

From the data of the patient groups mean and standard deviation (SD) were calculated with statistic analysis.

Our statistical results were compared with Bolton’s ratios (Table 3).

Table 3. Comparing Bolton’s values and our values

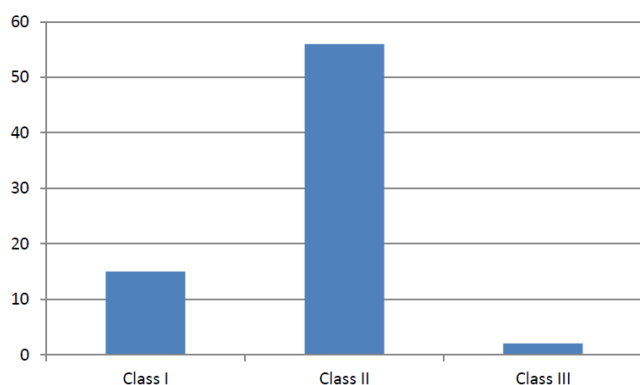
Bolton	$x-1S_D$	$x$	$x+1S_D$
$\Sigma 12$	89.4	91.3	93.2
$\Sigma 6$	75.6	77.2	78.9
Own	$x-1S_D$		$x+1S_D$
$\Sigma 12$	90.5	91.14	91.78
$\Sigma 6$	77.29	78.17	79.05

The marginal mean results of our patient groups differed from Bolton’s results to some extent, but showed no significant difference compared to Bolton's means (Table 4).

**Table 4.** The results of statistical analysis

t value	1.1	-0.24
Range of sample	15	11.85
Coefficient of variation %	11.37%	7.15%

During measurements groups were made based on gender and tooth anomalies. Differences in genders were also examined. It can be stated that among female patients the occurrence of Bolton discrepancy was more frequent, though among our orthodontic patients there were more females.

**Figure 2.** Bolton discrepancy among classes

The Bolton discrepancy according to the Angle's classification method, was also compared (Figure 2) within Angle classes. Our results showed that most dental arch discrepancies occurred within Angle Class II., 56 cases out of all Angle cases. 15 discrepancy cases were observed in Angle Class I, while in Angle Class III altogether 2 (Figure 2).

## 4. Discussion

In several publications of the dental literature tooth-size discrepancies and occlusion differences have been compared in different population groups.

Lew and Keng<sup>4</sup> examined the tooth-size in the population of Singapore. They found smaller frontal incisions and greater lateral incisions in the maxilla.

In the south Chinese population they generally found greater teeth compared to Bolton's standards, so in this ethnic group Bolton standards cannot be used.<sup>5</sup>

Araujo and Souki (2003) examined correlation between anterior tooth size discrepancies and Angle Class differences. They found that the prevalence of anterior tooth-size discrepancies was the greatest in Class III, opposed to cases in Class I and Class II.<sup>6</sup>

At the Shiraz University of Medical Sciences similar studies were concluded in Iran. Based on the data of 200 patients tooth-size discrepancies prevalence was significantly frequenter in Class III cases compared to Class II, but no difference was found compared to Class I.<sup>7</sup>

The study on the Spanish population showed significant deviation from Bolton values. Discrepancies were found primarily in the anterior region. Therefore, in their case calculations have to be made based on their own data and not the data of the American population.<sup>8</sup>

Earlier studies proved that etiologic factors can also play part in the development of Bolton discrepancy. E.g. in Class III because of mandibular prognathia lower teeth with greater mesiodistal dimension can be found, which can cause Bolton deviation.<sup>9</sup>

Based on our own results we can state that the measured data of the population we examined do not differ significantly from Bolton values, consequently the Bolton diagnostic system applies to the population of the south Transdanubian region of Hungary.

## 5. Conclusions

The ratio between the size of the maxillary and mandibular teeth can be different in different populations.

Examining according to class deviations Bolton deviation occurs most frequently in Angle II.

Since teeth-size deviation can cause unfavorable esthetic results, Bolton analysis cannot be ignored during orthodontic diagnosis and treatment planning. In case of greatly crowded teeth the two possible alternatives of treatment are the expansion of the dental arch or extraction. However, it is important to note that with extraction we ourselves can cause tooth-size discrepancy.

As a conclusion, to have a proper occlusion at the end of the treatment, so that the final result should be pleasing both for the patient and for us, extraction has to be planned in case of each single patient according to the requirements of the given case.

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