Tooth size discrepancies in Irish orthodontic patients among different malocclusion groups

Gerard O'Mahony[a]; Declan T. Millett[b]; Mark K. Barry[c]; Grant T. McIntyre[d]; Michael S. Cronin[e]

ABSTRACT

Objective: To determine the prevalence of tooth size discrepancies (TSDs) in an Irish orthodontic population among different malocclusion groups.

Materials and Methods: From 850 pretreatment sets of orthodontic models at a university clinic, 240 were selected with 30 female and 30 male sets for each malocclusion (Class I, Class II division 1, Class II division 2, and Class III). Digital models were produced, and the mesial and distal contact points were digitized to calculate overall and anterior tooth size ratios. The differences between the male and female groups and among the malocclusion groups were analyzed using two-way analysis of variance (ANOVA) ($P < .05$).

Results: A clinically significant anterior TSD (more than two standard deviations from the Bolton means) existed in 37.9% of the subjects. No differences existed in the prevalence of overall TSDs between the male and female groups ($P = .5913$) or among the malocclusion groups ($P = .0809$). For the mean anterior tooth size ratios in the male group, the values for Class III and Class II division 2 were higher than in Class II division 1, and the value for Class II division 2 was higher than in Class I ($P = .0184$).

Conclusions: The prevalence of anterior tooth size discrepancies in this sample of Irish orthodontic patients was 37.9%. There were no statistically significant differences in the prevalence of mean overall TSDs with regard to malocclusion or gender. In the male group, the mean anterior tooth size ratio was higher in Class III and in Class II division 2 malocclusion than in Class II division 1 and higher in Class II division 2 malocclusion than in Class I malocclusion. (*Angle Orthod.* 2011;81:130–133.)

KEY WORDS: Tooth size discrepancy; Bolton; Malocclusion

INTRODUCTION

A tooth size discrepancy (TSD) is a disproportion among the sizes of the individual teeth.[1] As significant tooth size discrepancies prevent an ideal occlusion being produced at the end of orthodontic treatment,

[a] Specialist in Orthodontics, HSE South, Cork University Dental School and Hospital, Wilton, Cork, Ireland.

[b] Professor, Oral Health and Development, Dental School, University College Cork, Ireland.

[c] Lecturer, School of Manufacturing Engineering, Dublin Institute of Technology, Dublin 1, Ireland.

[d] Consultant, Department of Orthodontics, Dundee Dental Hospital and School, Dundee, Tayside, UK.

[e] Lecturer, Department of Statistics, Western Gateway, University College Cork, Ireland.

Corresponding author: Prof Declan T. Millett, Oral Health and Development, Dental School, University College Cork, Ireland (e-mail: d.millett@ucc.ie)

the absence of a TSD is the seventh "key" for an ideal occlusion.[2] Overall, TSDs relate to all teeth excluding second permanent and third molars, whereas anterior TSDs involve the six anterior teeth.

Among patients undergoing orthodontic treatment, the prevalence of an overall TSD has varied from 4%–11%[3–6] but is about 5% in the nonorthodontic population.[7] Anterior TSDs, however, have a prevalence between 17% and 31% among orthodontic patients,[3,6,8–10] and this is similar to the prevalence of 20.5% in nonorthodontic patients.[7]

Trends have been identified in the prevalence of TSDs among the malocclusion groups. TSDs are more common in Class II division 1 malocclusions[8] and in Class III malocclusions.[5,10–13] Although Uysal and Sari[14] found no differences in tooth size ratios between malocclusion groups, a greater prevalence of larger tooth size ratios was noted when orthodontic and nonorthodontic groups were compared.

While in general men have bigger teeth than women,[15] this does not mean that they have larger

tooth size ratios or an increased prevalence of TSDs. In particular, Lavelle[16] and Smith et al.[17] found larger tooth size ratios in men than in women, but the differences at 0.6%–1.0% were not significant. This was confirmed by Mirzakouchaki et al.[18] in an investigation of Iranian-Azari subjects.

Ethnicity/race has also been found to be an influence on TSDs. Mean overall and anterior tooth size ratios in subjects with excellent occlusions have been found to be on average greater in Blacks than in either Mongoloids or Whites.[16] Smith et al.[17] found that Black people had the highest overall tooth size ratios (93.4%) followed by Hispanics (92.3%) and then Whites (91.2%). The anterior tooth size ratio was higher for Hispanics (80.5%) than for Black people (79.3%). Despite these findings, Othman and Harradine[19] noted that the trend to larger overall tooth size ratios in Black populations is unlikely to be clinically relevant. Significant discrepancies in the overall and anterior tooth size ratios have been found in Japanese, Iranian-Azari, Spanish, and Brazilian subjects.[4,18,20,21] Although the prevalence of tooth size ratios has been investigated in the British population,[6] and tooth size has been investigated in subjects with bimaxillary dental protrusion in a British subgroup,[22] specific data regarding overall and anterior tooth size ratios in the Irish population are not available.

The most common method of assessing a TSD involves the measurement of the mesiodistal widths of teeth using conventional fine-pointed calipers or digital calipers.[1] The development of digital scanning of study models has facilitated the automated calculation of tooth size ratios once the mesial and distal points of each tooth have been identified.[20,23,24] Measurements derived using 3D digital study models have been found to be an appropriate alternative to those derived using plaster models and digital calipers[20,23,24] with the advantages of being faster and providing easier storage of data.[25]

The aim of this study is to determine the prevalence of tooth size discrepancies (TSDs) in Irish orthodontic patients among different malocclusion groups using 3D digital study models.

MATERIALS AND METHODS

From 850 pretreatment sets of orthodontic study models at a university clinic, models were identified that fulfilled the following criteria:

- Permanent central incisor-first permanent molar erupted in each quadrant
- Subjects of Irish ethnic background determined from case records
- No retained primary teeth
- No abnormal tooth morphology
- No previous orthodontic treatment
- No factors which prevented accurate measurement of mesiodistal tooth widths including restorations, fractured teeth, or broken teeth on models

The first 60 sets of each malocclusion subgroup (Class I, Class II division 1, Class II division 2, and Class III), with 30 male and 30 female sets in each group, were selected to produce a total sample of 240 model sets. The incisor relationship was classified according to the British Standards Institute classification.[26] The severity of the malocclusion or skeletal relationship was not assessed. The models were scanned using an R250 orthodontic study model scanner (3Shape A/S, Copenhagen, Denmark) to produce digital images and were then evaluated using OrthoAnalyzer (3Shape A/S). The mesial and distal aspects of all teeth (excluding the second and third permanent molars) were landmarked by one assessor. The overall and anterior tooth size ratios according to Bolton[1] were then automatically calculated. Using SAS (version 9.1.3, SAS Institute Inc, Cary, NC), differences were calculated between the classes, with comparisons being adjusted using the Sidak method[27] to preserve the overall type I error rate at 5%. Residual analyses were performed to confirm the adequacy of the analysis of variance (ANOVA) models. Intraobserver reliability for landmark identification was assessed by relandmarking a 10% random sample of the digital images (24 model sets across the entire sample) 6 weeks after the initial assessment and evaluating differences in the automatically calculated anterior and overall Bolton ratios using two-way ANOVA.

RESULTS

Within this study sample 37.9% had a clinically significant mean anterior TSD, as defined by those cases having ratios more than two standard deviations from the means in Bolton's study[1] of cases with good occlusions. There were no statistically significant errors associated with the measurement of either the mean overall tooth size ratios (mean difference = .004; SD .011) or the mean anterior tooth size ratios (mean difference = .001; SD .014). For the mean overall tooth size ratios, no statistically significant differences were found between the genders (Tables 1 and 2) ($P = .5913$) or among the malocclusion classes ($P = .0809$). For the mean anterior tooth size ratios (Tables 3 and 4), there was an interaction between gender and the incisal class ($P = .0184$). There were differences between the incisal classes ($P = .0143$) and, as the interaction was significant, these differences between incisal classes were not the same for the two genders. For the female group there were no differences between the incisal classes.

Table 1. Mean Overall Tooth Size Ratios

| | Gender | | | | | | | | |
| | Female | | | Male | | | Total | | |
Malocclusion	n	Mean	SD	n	Mean	SD	n	Mean	SD
Class I	30	.921	.022	30	.924	.022	60	.923	.022
Class II division 1	30	.918	.018	30	.918	.024	60	.918	.021
Class II division 2	30	.923	.022	30	.928	.021	60	.926	.022
Class III	30	.929	.021	30	.927	.022	60	.928	.022
Total	120	.923	.021	120	.924	.022	240	.924	.022

Table 3. Mean Anterior Tooth Size Ratios

| | Gender | | | | | | | | |
| | Female | | | Male | | | Total | | |
Malocclusion	n	Mean	SD	n	Mean	SD	n	Mean	SD
Class I	30	.796	.032	30	.784	.029	60	.790	.031
Class II division 1	30	.793	.033	30	.779	.036	60	.786	.035
Class II division 2	30	.794	.031	30	.811	.027	60	.802	.030
Class III	30	.796	.032	30	.803	.030	60	.799	.031
Total	120	.794	.032	120	.794	.033	240	.794	.032

DISCUSSION

The prevalence of clinically significant anterior TSDs[1] in this Irish sample (37.9%) is higher than the recorded 17.4% in a British orthodontic population.[6] The prevalence, however, falls between that reported in a US population by Freeman et al.[9] and a Dominican American population by Santoro et al.[3] Furthermore, the overall mean tooth size ratio in the Bolton study was .91 compared to .92 in the present study, and the mean anterior tooth size ratio in the Bolton study was .77 compared to .79 in the present study.

When considering the mean overall tooth size ratios, there were no statistically significant differences between men and women corroborating with previous studies that have identified minor (statistically insignificant) differences between men and women.[16,17,19] Furthermore, we were unable to find any statistically significant differences in the mean overall tooth size ratios between the different malocclusion groups. This is in accordance with the findings of Uysal and Sari[14] who identified no differences in tooth size ratios between malocclusion groups in a Turkish population, but contrasts with Nie and Lin[28] who identified a higher prevalence of increased overall tooth size ratios in Class III malocclusions compared to Class I and Class II malocclusions in a Chinese population.

In this study, the mean anterior tooth size ratios exhibited no statistically significant differences between genders and no statistically significant differences among the malocclusion groups. This is similar to the findings by Crosby and Alexander[8] and Araujo and Souki.[10] There was a difference in the mean anterior tooth size ratios among the malocclusion groups for men. The highest mean anterior tooth size ratios for men were for Class II division 2 (.811) and for Class III (.803) compared to Class I (.784) and Class II division 1 (.779). This trend towards higher tooth size ratios in Class III malocclusion was noted previously by Ta et al.[12] in a Chinese population and Alkofide and Hashim[13] in a Saudi population. Strujic et al.[5] found there was a tendency for mandibular tooth excess in subjects with Class III malocclusions and for maxillary tooth excess in subjects with Class II malocclusions in an orthodontic population. Othman and Harradine[19] suggested that this may be another factor that complicates the treatment of Class III malocclusion. There was also a higher prevalence of mean anterior tooth size ratios in the male Class II division 2 malocclusion group which may have restorative implications.

The high prevalence of anterior TSDs in this Irish orthodontic population suggests that a tooth size analysis should be conducted at the treatment planning stage. Where significant TSDs are detected, this is normally accommodated by the reduction or augmentation of tooth tissue.[29]

CONCLUSIONS

- The prevalence of anterior tooth size discrepancies in this sample of Irish orthodontic patients was 37.9%.

Table 2. Analysis of Mean Overall Tooth Size Ratios

| Type III Tests of Fixed Effects | | | | |
Effect	NumDF	DenDF	F Value	Pr > F
Gender	1	232	.29	.5913
Class	3	232	.27	.0809
Gender*Class	3	232	.38	.7661

(Num DF = Numerator Degrees of Freedom; Den DF = Denominator Degrees of Freedom; F Value = F-statistics value; Pr > F: *P* value).

Table 4. Analysis of Mean Anterior Tooth Size Ratios

| Type III Tests of Fixed Effects | | | | |
Effect	NumDF	DenDF	F Value	Pr > F
Gender	1	232	0.00	.9868
Class	3	232	3.60	.0143
Gender*Class	3	232	3.41	.0184

(Num DF = Numerator Degrees of Freedom; Den DF = Denominator Degrees of Freedom; F Value = F-statistics value; Pr > F: *P* value).

- There were no statistically significant differences in the prevalence of overall TSDs with regard to malocclusion or gender. In men, the mean anterior ratio was higher in Class III and in Class II division 2 malocclusion than in Class II division 1 malocclusion and higher in Class II division 2 malocclusion than in Class I malocclusion.

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