Odontometric evaluation of mandibular premolars with tooth shape deviation
A case-control study

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ABSTRACT

Objective: To evaluate the mean dimensions and morphologic characteristics of mandibular premolars that had mesiodistally elongated and faciolingually squeezed tooth shape deviations (MnP-TSD) and determine the population prevalence of this anomaly.

Materials and Methods: Clinical photographs and study models were made for all new patients with MnP-TSD teeth who were seen over 20 years. The mesiodistal (MD) and faciolingual (FL) dimensions of the anomalous premolars were measured. MD/FL indices and MD $\times$ FL mm^2 occlusal crown areas were calculated and means and standard deviations were derived. Male and female means from the mandibular first and second anomalous premolars (MnP1/MnP2-TSD) were statistically compared against gender-specific means derived from published normative data using Student's *t*-tests and chi-square tests.

Results: Fifty-six individuals (33 male and 23 female) with MnP-TSD were identified, giving a male to female ratio of 1.4:1, while the prevalence rate in the indigenous British population was estimated to be 0.6%. The MD widths of the MnP1-TSD and MnP2-TSD teeth were approximately 1 mm wider than normal, while the FL diameters were about 0.5 mm and 1.5 mm narrower respectively, for the first and second premolar teeth. The MD/FL indices, instead of being under 90 as usual were above 100, while the mean MD/FL mm^2 crown surface areas were normal.

Conclusions: This study supplies odontometric dimensional and morphologic data on MnP-TSD teeth that provide a reference source for future comparisons. (*Angle Orthod.* 2012;82:785–791.)

KEY WORDS: Compressed; Squeezed; Elongated; Tooth shape deviation; Premolars

INTRODUCTION

Maxillary lateral incisors, third molars, and mandibular second premolars are the teeth that are most often developmentally absent.[1] The latter are also prone to either late[2] and or supernumerary development,[3] ectopia,[4] and morphologic aberration.[5,6]

Butler has described the presence of morphogenetic fields within embryonic jaws that differentiate into incisor, canine, and molar regions,[7] each of which has a continuously graded internal environment.[8] It is acknowledged in evolution that the teeth that develop towards the end of a series in the critical marginal areas of the dental lamina seem to be less stable and more susceptible to variation than those at the front.[9]

Normal mandibular premolars display round occlusal shapes, with faciolingual (FL) diameters that are slightly larger than the mesiodistal (MD) widths, yet two types of aberration may be seen.

The first involves megadontia where there is gross enlargement of both the FL and MD dimensions of the tooth[10] (Figure 1), while the second is where the tooth has an increased MD dimension but a reduced FL dimension (Figure 2).

The first report of this latter type of aberration seems to have been made by Dahlberg in 1951 when he described a white woman whose bilateral second premolars had experienced a "compression factor." This resulted in the premolars being squeezed faciolingually with a compensatory increase in their mesiodistal widths, but with no consequential loss of

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Figure 1. A megadont lower second premolar.

tooth bulk.[11] Subsequent case reports have continued to illustrate sporadic occurrences in Japanese,[12] African,[13,14] white,[15–18] and Asian individuals.[14]

Peck and Peck[17] have also demonstrated the existence of this type of anomaly in both mandibular first (MnP1) and second premolar teeth (MnP2),

Figure 2. A lower second premolar with tooth shape deviation.

Figure 3. Bilateral occurrence of lower second premolars with tooth shape deviation.

coining the term premolars with tooth shape deviation (MnP-TSD).

A small study of 10 male and 8 female patients with MnP-TSD has recently provided gender combined means and standard deviations for the MD and FL dimensions of these anomalous teeth.[14] From these data a dentally modified anthropologic proportional index, described as the MD/FL index,[19] was used to quantify each premolar tooth's morphology, and the occlusal crown areas for all of the MnP-TSD teeth were also calculated (MD $\times$ FL mm^2).

The findings indicated that unlike normal first and second mandibular premolars whose mean proportional MD/FL gender combined indices were under 90, those for the MnP-TSD teeth were always above 100. However, the mean occlusal surface areas were remarkably similar to normal, indicating that the tooth bulk of these anomalous premolars were not diminished as a result of the MD elongations and the compensatory FL reductions. In addition, patients with severe expressions of premolar tooth shape deviation (ie, high MD/FL indices) seemed to have a greater prevalence toward both bilateral occurrence (Figure 3) and distinctive torsion of the crown of the anomalous tooth in a mesiolingual/distofacial direction (Figure 4).[14]

The aim of this study is to derive gender-specific odontometric mean MD and FL dimensions, morphologic proportional MD/FL indices, and MD $\times$ FL mm^2 occlusal crown areas for both MnP1-TSD and MnP2-TSD teeth and to deduce this anomaly's prevalence in the British population.

MATERIALS AND METHODS

Over the course of two decades of new patient orthodontic consultation clinics in an English hospital, consent was sought to take clinical photographs and dental impressions for each patient who presented

Figure 4. Mesiolingual/distobuccal torsiversion of a lower second premolar.

with a MnP-TSD. MD and FL dimensions of the study model MnP-TSD teeth were subsequently measured to two decimal points using an electronic digital caliper on two separate occasions at least a month apart. Thereafter, each tooth's paired readings were combined to derive average measurements, and these were used to calculate their MD/FL proportional indices and occlusal crown areas (MD $\times$ FL mm^2).

The data were entered onto a spreadsheet and means and standard deviations were calculated. Male and female means from the MnP-TSD samples were then compared against gender and tooth specific means derived from published normative data.[20]

The null hypothesis was that there are no statistically significant differences between the odontometric dimensions of MnP-TSD teeth and normal mandibular premolars that are found in the population, and a Student's *t*-test and chi-square test were used to

Figure 5. Bilateral occurrence of lower first premolars with tooth shape deviation.

Figure 6. Bilateral occurrence of both lower first and second premolars with tooth shape deviation.

evaluate this assumption. A probability level of less than 5% ($P < .05$) was chosen to indicate a statistical difference.

RESULTS

Over the 20-year period, 56 individuals were found to have either one or more lower second and/or first permanent premolar teeth with tooth shape deviation. Thirty-three male and 23 female patients comprised the sample, of which all of the male patients and 21 of the female patients were white, with two other female patients being of mixed race, each separately having a white father and a Chinese mother.

As a consequence, the male to female ratio was derived to be 1.4:1. On the basis that approximately 10,000 new patient consultations would have been seen over this period, the prevalence of MnP-TSD within the indigenous British population was also estimated to be 0.56%. The mean age of the male sample was 13.9 years (SD 2.9; range: 10.8–23.2), and the mean age of the female sample was 15.2 years (SD 6.9; range: 10.2–43.9).

Of the 33 male patients, 22 had bilateral MnP2-TSD teeth (67%), of which two had an additional single MnP1-TSD tooth, and another two had bilateral MnP1-TSD teeth. Eight boys (24%) had unilateral MnP2-TSD teeth of which six were on the right, while three of the boys (9%) had only bilateral MnP1-TSD teeth (Figure 5). Altogether, there were 12 male MnP1-TSD teeth and 52 male MnP2-TSD teeth, of which only 50 were available to measure because two boys with bilateral MnP2-TSD had inadvertently had one of their anomalous second premolars extracted prior to the collection of their records.

Of the 23 girls, 10 had bilateral MnP2-TSD teeth (44%) of which two additionally had bilateral MnP1-TSD teeth (Figure 6). Another 10 girls (44%) had

Table 1. The Odontometric Measurements of Male Mandibular Premolar Teeth With Tooth Shape Deviation

Male Samples (n = Number of Teeth)	MD Diameter, mm		FL Diameter, mm		MD/FL × 100 Index		MD × FL, mm²	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
MnP1-TSD (n = 12)	8.09	0.46	7.25	0.43	111.9	5.9	58.7	6.1
MnP1 normal reference value[20] (MD n = 159 & FL n = 157)	6.89	0.63	7.92	0.47	87.0	–	54.6	–
Difference	1.20***	–	−0.68***	–	24.9	–	4.1	–
MnP2-TSD (n = 50)	8.32	0.72	6.96	0.66	120.5	14.3	57.9	8.4
MnP2 normal reference value[20] (MD n = 132 & FL n = 132)	7.22	0.47	8.62	0.45	83.8	–	62.2	–
Difference	1.10***	–	−1.67***	–	36.8	–	−4.3	–

*** $P < .001$.

unilateral MnP2-TSD teeth, of which seven were on the right. One of these patients also had bilateral MnP1-TSD teeth, and three other girls (12%) had bilateral MnP1-TSD teeth. Altogether, there were 12 female MnP1-TSD teeth and 30 female MnP2-TSD teeth, of which only 29 were available to measure because one patient refused to have dental impressions taken.

Table 1 shows the odontometric measurements of the male MnP-TSD teeth. The mean MD width for the male MnP1-TSD teeth was 8.09 mm (± 95% CI 8.35–7.83), while the mean FL diameter was 7.25 mm (± 95% CI 7.49–7.00). In comparison to normal male mandibular first permanent premolars, the mean MD and FL widths of the male MnP1-TSD teeth were significantly 1.2 mm wider and 0.7 mm narrower, respectively ($P < .001$).

The mean MD width for the male MnP2-TSD teeth was 8.32 mm (± 95% CI 8.52–8.12), while the mean FL diameter was 6.96 mm (± 95% CI 7.14–6.77). In comparison to normal male mandibular second permanent premolars, the mean MD and FL widths of the male MnP2-TSD teeth were significantly 1.1 mm wider and 1.7 mm narrower, respectively ($P < .001$).

For all male MnP-TSD teeth, the MD/FL indices were above 100 (MnP2-TSD range 101–163), while the mean MD × FL mm² crown surface area products were reasonably normal.

Table 2 shows the odontometric measurements of the female MnP-TSD teeth. The mean MD width for the female MnP1-TSD teeth was 7.88 mm (± 95% CI 8.22–7.53), while the mean FL diameter was 7.30 mm (± 95% CI 7.58–7.02). In comparison to normal female mandibular first permanent premolars, the mean MD and FL widths of the female MnP1-TSD teeth were significantly 1.1 mm wider ($P < .001$) and 0.4 mm narrower ($P < .05$), respectively. The mean MD width for the female MnP2-TSD teeth was 8.07 mm (± 95% CI 8.33–7.82), while the mean FL diameter was 6.79 mm (± 95% CI 7.01–6.56).

In comparison to normal female mandibular second permanent premolars, the mean MD and FL widths of the female MnP2-TSD teeth were significantly 1.0 mm wider and 1.6 mm narrower, respectively ($P < .001$).

For all the female MnP-TSD teeth, the MD/FL indices were above 100 (MnP2-TSD range 101–161), while the mean MD × FL mm² crown surface area products were reasonably normal.

In one example of an extracted MnP2-TSD tooth, the external root morphology seems to follow the same characteristic FL squeezing and MD elongation of the crown (Figure 7a,b) as does the internal dental anatomy (Figure 8a,b).

Tables 3 and 4, respectively, show the number of male and female patients with either severe or weak MnP2-TSD expressions that either were or were not

Table 2. The Odontometric Measurements of Female Mandibular Premolar Teeth With Tooth Shape Deviation

Female Samples (n = Number of Teeth)	MD Diameter, mm		FL Diameter, mm		MD/FL × 100 Index		MD × FL, mm²	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
MnP1-TSD (n = 12)	7.88	0.61	7.30	0.50	108.0	5.0	57.9	7.9
MnP1 normal reference value[20] (MD n = 134 & FL n = 134)	6.78	0.70	7.66	0.50	88.5	–	51.9	–
Difference	1.10***	–	−0.36*	–	19.5	–	6.0	–
MnP2-TSD (n = 29)	8.07	0.70	6.79	0.62	119.8	12.0	54.8	6.7
MnP2 normal reference value[20] (MD n = 100 & FL n = 100)	7.07	0.46	8.38	0.52	84.4	–	59.2	–
Difference	1.00***	–	−1.60***	–	35.5	–	−4.5	–

* $P < .05$; *** $P < .001$.

Figure 7. (a) External mesiodistal appearance of a lower second premolar with tooth shape deviation. (b) External buccolingual appearance of a lower second premolar with tooth shape deviation.

associated with crown torsions. The differentiation between severe and weak expressions was arbitrarily made if the premolar's MD/FL index was respectively either greater or less than 1 standard deviation from the MnP-TSD index sample mean. These tables show that it is only the male patients with severe MnP2-TSD expressions whose anomalous teeth were significantly more likely to have crown torsions ($P < .01$).

Figure 8. (a) Sectioned mesiodistal internal appearance of a lower second premolar with tooth shape deviation. (b) Sectioned buccolingual internal appearance of a lower second premolar with tooth shape deviation.

Table 3. The Number of Male MnP2-TSD Teeth With Either Severe or Weak Expressions of Tooth Shape Deviation, With or Without Crown Torsion[a]

Male MnP2-TSD Teeth	With Torsion	Without Torsion	Totals
MD/FL index ≤ 1 SD (135)	15	27	42
MD/FL index > 1 SD (135)	7**	1	8
Total	22	28	50

[a] MnP2-TSD indicates mandibular second premolar tooth shape deviation. Chi-square = 7.314; DF = 1.
** $P < .01$.

Tables 5 and 6, respectively, show the number of male and female patients with either unilateral or bilateral MnP2-TSD teeth that either had severe or weak expressions of TSD. The analysis of these data shows that there were no significant associations between these two features for either gender.

Tables 7 and 8, respectively, show the number of male and female patients with either unilateral or bilateral MnP2-TSD teeth that either did or did not have crown torsions. From these it can be seen that only the male patients with bilateral MnP2-TSD teeth were significantly more likely to have crown torsions of the anomalous teeth ($P < .01$).

DISCUSSION

Although the data in this study were analyzed separately for each gender, the measurements from right and left MnP-TSD teeth were pooled as previous research has shown that dimensions of teeth from both sides of the dental arch are similar to each other.[21]

Despite a systematic study of MnP-TSD teeth having been published before,[14] its small numbers forced the amalgamation of male and female data, thereby limiting its value, bearing in mind that sexual dimorphism exists between male and female teeth, with the former being significantly larger than the latter by an average of 0.3 mm for mandibular premolar teeth.[22]

This report of MnP-TSD teeth is therefore the largest to date, and it broadly corroborates previous observations of Garib and Peck.[14] For example, the MnP-TSD 1.4:1 male/female ratio that was found previously[14] was

Table 4. The Number of Female MnP2-TSD Teeth With Either Severe or Weak Expressions of Tooth Shape Deviation, With or Without Crown Torsion[a]

Female MnP2-TSD Teeth	With Torsion	Without Torsion	Totals
MD/FL index ≤ 1 SD (132)	6	19	25
MD/FL index > 1 SD (132)	1	3	4
Total	7	22	29

[a] MnP2-TSD indicates mandibular second premolar tooth shape deviation. Chi-square = 0.002; DF = 1; not significant.

Table 5. The Number of Male Unilateral and Bilateral MnP2-TSD Teeth With Either Severe or Weak Expressions of Tooth Shape Deviations[a]

Male MnP2-TSD Teeth	MD/FL Index ≤ 1 SD (135)	MD/FL Index > 1 SD (135)	Totals
Unilateral	8	0	8
Bilateral	34	8	42
Total	42	8	50

[a] MnP2-TSD indicates mandibular second premolar tooth shape deviation. Chi-square = 1.814; DF = 1; not significant.

Table 7. The Number of Male Unilateral and Bilateral MnP2-TSD Teeth With or Without Crown Torsion[a]

Male MnP2-TSD Teeth	With Torsion	Without Torsion	Totals
Unilateral	0	8	8
Bilateral	22**	20	42
Total	22	28	50

[a] MnP2-TSD indicates mandibular second premolar tooth shape deviation. Chi-square = 7.483; DF = 1.
** $P < .01$.

substantiated by exactly the same ratio derived from this larger study of similar ethnic origin.

In relation to the 0.56% population prevalence of MnP-TSD teeth that was found in this study of approximately 10,000 white English patients, it was interesting to note that a very similar prevalence of 0.5% was found by Barnes[13] in a study of nearly 4,000 black Ugandan children.

Tables 1 and 2 indicate that in comparison to normal mandibular premolars, on average the MD widths for both male and female MnP1-TSD and MnP2-TSD teeth were approximately 1 mm wider, while the FL diameters were about 0.5 mm and 1.5 mm narrower for the anomalous first and second premolar teeth, respectively. Similar dimensional differences have been described previously, but by virtue of the small sample size and gender amalgamation of the data,[14] these were as a trend rather than of any statistical significance.

The reversal of the usual FL dominance over the MD dimensions of mandibular premolars by roughly compensatory amounts in MnP-TSD teeth also explained the maintenance of near normal occlusal surface areas (MD × FL mm^2) as well as the change in the morphologic proportional MD/FL indices from always being under 90 to always being over 100, as previously reported.[14]

A former observational impression that severe MnP-TSD expressions were frequently accompanied by torsions of the crowns of the anomalous teeth in a mesiolingual/distofacial direction[14] was statistically borne out in this study (Tables 3 and 4), but only for male MnP2-TSD teeth (Figure 4).

Dental anthropologists have identified similar occlusal distortions in mandibular third molars that result in the buccal and lingual surfaces contacting the adjacent teeth rather than the usual mesial and distal surface contacts. This has been called torsiversion,[23] and it has been suggested that its appearance in male MnP2-TSD teeth may be atavistic[14] because similar occlusal torsions and measurable MD elongations and FL compressions have been found in mandibular third premolars (MnP3) of prehominid *Dryopithecus* fossils.[24]

The previous observation that severe MnP-TSD expressions seemed to be more frequently found in patients with bilateral occurrence[14] was not statistically confirmed for either gender in this study (Tables 5 and 6).

In contrast, Tables 7 and 8 show that anomalous teeth of only male patients with bilateral MnP2-TSD were significantly more likely to have crown torsions ($P < .01$).

In an attempt to rationalize why the MnP-TSD anomaly seems to occur in the population, referral to anthropologic studies provides some insight. Over the last 100,000 years human teeth have been reducing in all dimensions by 1% every 2000 years. In the last 10,000 years this rate has accelerated to 1% every 1000 years, with FL diameters reducing twice as fast as MD widths. The supposition is that with the advent of pottery, the elaboration of food processing has resulted in a relaxation of the natural selection mechanisms biased towards maintaining maximal usable crown substances. As such, it has been speculated that FL dimensions would be more susceptible to evolutionary reduction than MD widths, on the basis that stability of the latter would still be

Table 6. The Number of Female Unilateral and Bilateral MnP2-TSD Teeth With Either Severe or Weak Expressions of Tooth Shape Deviations[a]

Female MnP2-TSD Teeth	MD/FL Index ≤ 1 SD (132)	MD/FL Index > 1 SD (132)	Totals
Unilateral	9	0	9
Bilateral	17	3	20
Total	26	3	29

[a] MnP2-TSD indicates mandibular second premolar tooth shape deviation. Chi-square = 1.506; DF = 1, not significant.

Table 8. The Number of Female Unilateral and Bilateral MnP2-TSD Teeth With or Without Crown Torsion[a]

Female MnP2-TSD Teeth	With Torsion	Without Torsion	Totals
Unilateral	3	6	9
Bilateral	4	16	20
Total	7	22	29

[a] MnP2-TSD indicates mandibular second premolar tooth shape deviation. Chi-square = 0.603; DF = 1; not significant.

required to maintain regular interproximal contacts and a functional occlusion.[25]

From a clinical management perspective, there are potential orthodontic implications for treating patients with such tooth shape deviations. The additional space required for accommodating broader MnP-TSD teeth can have an adverse effect either on their own positioning or on the alignment of other teeth elsewhere in the arch. Otherwise, in the absence of any crowding, the presence of a MnP-TSD tooth would adversely affect the Angle classification of the ipsilateral molars through the posterior displacement of these teeth.

Obviously, in those cases where a patient with MnP-TSD deviation has dental crowding, the choice of relieving extractions would be influenced by the presence of an anomalous premolar tooth.[14] Conversely, treating such cases nonextraction could be complicated by the MnP-TSD teeth resisting orthodontic derotation and/or torqueing because of their broad MD root surface areas, not to mention that achieving correct intercuspation of the anomalous teeth would also be limited.[14]

Since identification of the human genome in 2003 succeeded the start of this study by over a decade, the option to prospectively undertake genetic investigation for all of the patients was not possible. However, such an opportunity now exists for future studies to extend research towards evaluating both familial/inheritance factors and genetic origins for patients with MnP-TSD teeth.

CONCLUSIONS

- MD/FL indices and occlusal-crown area MD × FL products may be used to differentiate between MnP-TSD and megadont premolar teeth because while both anomalies have MD/FL indices over 100, only megadont premolars have above average occlusal crown areas, and this is diagnostic.[14]
- The data in this report now provide a gender-specific reference base for some dimensional and morphologic characteristics of MnP-TSD teeth.
- In general, bilateral occurrence of the MnP-TSD anomaly predominates, as does dextrality in those cases with unilateral involvement alone.

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