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Prevalence and side preference for tooth grinding in twins

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Abstract

Background: Estimates of the prevalence of tooth grinding in children range considerably, reflecting different methods of recording. The main aims of this study were to determine the prevalence of tooth grinding in monozygotic (MZ) and dizygotic (DZ) twin pairs by assessing wear faceting on the primary canines, and to compare the faceting on the right and left to determine whether children have a side preference for grinding.

Methods: The sample consisted of 116 MZ twin pairs and 124 dizygous DZ twin pairs, all participants in an ongoing study of dento-facial development at the dental schools in Adelaide and Melbourne. Evidence of wear faceting on primary maxillary and mandibular canine tips was recorded from dental casts, and the side with the larger wear facet recorded. Types of occlusal relationship, handedness, zygosity and gender were also recorded, and associations between variables analysed statistically.

Results: Canine tip wear facets were found in 100 per cent of the sample, and grinding was lateralized in 59 per cent of children. MZ twin pairs showed a higher discordance for grinding side preference than DZ twin pairs (33.8 per cent compared with 16.8 per cent), providing evidence of a mirror-imaging effect for grinding side preference. There was no strong evidence that individuals had the same preference for grinding side and handedness, although right-handers (RH) showed a preference for a grinding side more often than non-right-handers (NRH) (63.6 per cent compared with 51.2 per cent), consistent with previous findings that RHs display more cerebral lateralization than NRHs.

Conclusions: Tooth grinding appears to be a universal phenomenon in children and is commonly expressed more on one side than the other. The significantly higher discordance for grinding side preference in MZ twin pairs compared with DZ twin pairs may reflect a mirror-imaging effect in the former. However, at present we have no evidence to suggest that handedness and preferred tooth grinding side are associated.

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Key words: Twins, bruxism, side preference, handedness, primary teeth.

Abbreviations and acronyms: DZ = dizygotic; MI = mirror imaging; MZ = monozygotic; NRH = non-right-handedness.

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INTRODUCTION

Bruxism remains a controversial phenomenon in the dental literature. In the past, peripheral factors such as occlusal discrepancies were considered to be the prime aetiological factors associated with bruxism. However, more recent and scientifically reliable research provides for a central mechanism. A multifactorial model seems most appropriate, encompassing predominantly central factors (patho-physiological and psychological) and to a lesser degree, peripheral factors (such as occlusal morphology).[1] Whether there is a bruxing entre in the brain associated with, or similar to, the central pattern generator for mastication[2] remains to be discovered.

The existence and extent of bruxism, including tooth grinding and clenching, has always been difficult to assess directly in humans as it is generally a subconscious event that cannot be demonstrated on cue. Pavone[3] stated that the prevalence of bruxism seems to vary according to "the definition used, diagnostic criteria applied, type of population samples, types of questionnaires and the design of the study". Proof of this is evident in numerous clinical studies reporting varying results for the prevalence of bruxism, with estimates ranging between 7 to 88 per cent in children and between 15 to 88 per cent in adults.[4] Recording occlusal wear facets on teeth and on dental casts is a common means of indirectly and retrospectively assessing tooth grinding, yet some argue that the facets may be due to contacts during normal masticatory function.[5-7] Kaidonis *et al.*[8] dispute this and claim that all parties can be satisfied by only recording wear facets on tooth surfaces that clearly do not contact during mastication, i.e., faceting on canine tips. At present, we know very little about whether individuals tend to favour one side over the other in grinding. If a side preference for tooth grinding leading to the production of wear facets does exist, it could be associated with

local factors (e.g., dental occlusion), or due to central influence (e.g., reflecting cerebral lateralization).

There is also little information available about the relative contribution of genetic and environmental influences to observed variation in bruxing activity. Comparisons between monozygous (MZ) and dizygous (DZ) twin pairs have much to offer in this respect. Additionally, by focusing on MZ twin pairs who have very similar dentitions (due to the strong genetic influences on dental variability),[9] dental occlusion is essentially "controlled for". Thus, any differences in wear facet patterns between MZ co-twins are most likely to be of central origin rather than due to local occlusal factors.

It has long been recognized that there is a higher frequency of non-right-handedness (NRH) amongst twins and their families compared with individuals from the general population; around 20 per cent compared with 10 per cent, respectively.[10] This higher frequency of NRH has been suspected to reflect altered cerebral lateralization,[11] which itself is associated with controversial "nature versus nurture" hypotheses regarding its aetiology.[12] Additionally, discordance for handedness has been shown to occur in 29 per cent of MZ twin pairs,[10] indicating that the mechanism determining handedness is not entirely genetic. To date, however, possible associations between bruxism and body lateralization have not been explored, as far as we are aware. If bruxism is shown to be lateralized, it would be of considerable interest to determine whether, like handedness, it is mirror imaged in some MZ twin pairs.

The aims of this study were to: (1) calculate the prevalence of tooth grinding in a sample of twins with primary dentitions, and to determine whether there was any evidence of differences between boys and girls, and between MZ and DZ groups; (2) ascertain whether a side preference for tooth grinding existed within individuals and if so, to determine whether it was associated with handedness and thus cerebral lateralization; (3) determine whether there was a higher concordance for the prevalence of tooth grinding in MZ twin pairs than DZ twin pairs; (4) determine whether there was a higher concordance for grinding side preference in MZ twin pairs than DZ twin pairs; and (5) determine whether twin pairs who exhibited mirror imaging for handedness also showed mirror imaging for grinding side preference.

METHOD

Over 600 pairs of twins are now enrolled in an ongoing investigation of dento-facial variation in Australian twins and their families being carried out at the dental schools in Adelaide and Melbourne. Initially, most of the twins examined were teenagers, with most or all of their permanent teeth present, but more recently the study was extended to include children with primary dentitions who are being followed up at mixed and permanent dentition stages. Various observations and records have been obtained from the twins including direct oral examinations, dental impressions from which stone casts are prepared, photographs of the face and dentition, finger and palm prints, and also information relating to handedness, birth weight and length, and medical histories. Zygosities have been confirmed either by comparison of genetic markers in blood or by DNA analysis of buccal cells.[13] The probability of monozygosity, given concordance for all systems analysed, is greater than 99 per cent.[9]

The study sample

The sample for this investigation consisted of 480 individuals (240 twin pairs, including 116 MZ pairs and 124 DZ pairs), in the primary or early mixed dentition stages of dental development (provided all primary canines were present and intact).

Cast analysis

Cast analysis consisted of recording the presence of faceting on canine tips and assessing visually whether one side had noticeably more wear or a larger facet than the other in both the maxilla and mandible. No facets on labial or lingual surfaces were considered. To ensure that facets had been produced during extreme lateral mandibular movements, they were matched with those in the opposing arch. The presence of wear facets on canine tips that could only be approximated during extreme excursive movements was taken as evidence that tooth grinding had occurred. Left and right canines were compared from occlusal, labial, and lingual views, and by articulating the casts in extreme lateral positions. The canine tip with the most wear in both the maxilla and mandible was recorded. While bilateral wear faceting provides evidence of grinding having occurred on both sides, a larger facet on one side than the other was taken to indicate an overall preference for the grinding habit on that side. Any evidence of erosion (dentine cupping in either arch) was also noted.

Occlusal relationships were recorded to determine if any particular occlusal features were associated with higher than expected frequencies of wear faceting or particular patterns. Left and right canine and molar relationships, presence of any cross-bites, and degree of overbite and overjet were recorded. A cross-bite was recorded even if it did not directly involve the canines on that side, as cross-bites may interfere with mandibular movement to extreme lateral positions (via deflective contacts).

Once cast analysis was complete, it was decided that only wear on maxillary teeth would be used to determine whether a child was a tooth grinder, and which side was preferred. This was because the maxillary canines consistently showed more definite wear facets than the mandibular canines. Thus, a "bruxer" was someone with wear on either or both of their maxillary canines, and the canine showing the most wear was marked as the preferred grinding side.

Table 1. Distribution of handedness and tooth grinding side preference according to gender, zygosity and handedness

	Handedness			Grinding side preference			
	N	RH	NRH	N	Right	Left	None
Gender							
Male	216	173 (80.1%)	43 (19.9%)	216	67 (31.0%)	60 (27.8%)	89 (41.2%)
Female	229	182 (79.5%)	47 (20.5%)	229	72 (31.4%)	63 (27.5%)	94 (41.0%)
Combined	445*	355 (79.8%)	90 (20.2%)	445*	139 (31.2%)	123 (27.6%)	183 (41.4%)
Zygosity							
MZ	216	166 (76.9%)	50 (23.1%)	228	76 (33.3%)	66 (28.9%)	86 (37.7%)
DZ	225	187 (83.1%)	38 (16.9%)	236	69 (29.2%)	66 (28.0%)	101 (42.8%)
Combined	441*	353 (80.0%)	88 (20.0%)	464*	145 (31.3%)	132 (28.4%)	187 (40.3%)
Handedness							
Right				358	117 (32.7%)	99 (27.7%)	142 (39.7%)
Non Right				91	25 (27.5%)	24 (26.4%)	42 (46.2%)
Combined				449*	142 (31.6%)	123 (27.4%)	184 (41.0%)

*Sample sizes do not add up to 480 (total number of participants) due to damaged casts or missing data for some twins.

Assessments of erosion were only recorded in the maxilla, as there were no cases of erosion in the mandible alone.

Data collection

Recordings were entered into a Microsoft Excel spreadsheet. Other data such as gender, zygosity and handedness obtained from existing records were added to the spreadsheet at the completion of cast analysis, ensuring that the recorder was not aware of the twins' gender, zygosity or handedness. Seven measures of handedness were recorded for most twins: writing, throwing a ball, holding a jug, operating scissors, drinking a glass of water, brushing teeth and holding a tennis racquet or beach bat. In this study, an individual was classified as being RH if six or more of the activities were carried out using the right hand. A person was considered NRH if five or less of the activities were carried out using the right hand. For those twins who did not undertake these activities, a questionnaire was answered by the child's parent/guardian regarding writing, drawing and throwing a ball. A child was considered NRH if any of these activities was performed with the left or both hands, and RH if all activities were completed with the right hand.

Double determinations

Double determinations were carried out for 10 per cent of the sample to assess reliability of the recording methods and percentage concordances were calculated. Frequencies of occurrence were calculated for study variables and chi-squared tests were used to test associations between variables using an SPSS statistics package. The level of statistical significance was set at 5 per cent.

RESULTS

Double determinations

Concordances between the first and second recordings were very high; above 90 per cent for all variables except for overbite and overjet, which were associated with values above 80 per cent. This indicates that the recording methods were generally very reliable.

Prevalence of tooth grinding in the primary dentition

The prevalence of tooth grinding in the primary dentition (assessed according to the presence of wear on either or both maxillary canines) was universal, at 100 per cent. There was no significant difference in frequency of occurrence between females and males, nor between MZ and DZ groups.

Handedness

We found that 79.7 per cent of the sample were RH, with NRH making up 20.3 per cent. These figures changed very little when separated into MZ/DZ and male/female groups (Table 1). Thirty per cent of MZ twin pairs were discordant for handedness, and 27 per cent of DZ twin pairs were discordant for handedness (Fig 1).

Side preference for tooth grinding

Side preference for grinding within individuals was approximately evenly distributed between right preference (31.6 per cent), left preference (27.4 per cent), and no preference (41 per cent), indicating that 59 per cent of individuals preferred a side for grinding. This distribution did not change significantly when the sample was separated into MZ and DZ twins or into males and females (Table 1).

Side preference for tooth grinding and handedness

The percentage of individuals who were concordant for handedness and preferred grinding side (i.e., being RH and preferring to grind on the right side) was 53.2 per cent (Fig 2). RHs tended to show more

Fig 1. Diagram showing prevalence of discordance for handedness in MZ and DZ twin pairs. (i) 30 per cent of MZ twin pairs were discordant for handedness. (ii) 27 per cent of DZ twin pairs were discordant for handedness.

Fig 2. Diagram showing prevalence of concordance and discordance for handedness and preferred grinding side preference in individuals. (i) 53.2 per cent of individuals were concordant for handedness and preferred grinding side.* (ii) 46.8 per cent of individuals were discordant for handedness and preferred grinding side.*

*Individuals without a recording for handedness and/or without a preferred grinding side were not included in this calculation.

preference for grinding side (either right or left) at 60.3 per cent, while NRHs showed less preference for grinding side at 53.8 per cent, but this finding was not statistically significant.

The percentage of MZ twin pairs who were discordant for preferred grinding side (preferring opposite sides to grind on, and thus exhibiting mirror imaging) was 30.4 per cent, as opposed to only 14 per cent in DZ pairs (Fig 3). This was statistically significant at $p<0.05$. Figure 4 shows dental casts of a pair of MZ twins who were discordant for grinding side preference and also handedness.

The percentage of MZ twin pairs who showed discordance for both handedness and preferred grinding side (e.g., one twin preferring the left for both grinding side and handedness, and the other twin preferring the right for both of these characteristics) was 7.5 per cent, compared with only 1.8 per cent for DZ twin pairs. This finding was also significantly different at $p<0.05$ (Fig 5). Twenty-five per cent of MZ twin pairs and 28 per cent of DZ twin pairs both showed the same handedness and side preference for grinding (Fig 6), a statistically non-significant finding.

Erosion

The prevalence of erosion in the primary dentition (assessed using presence of erosion in the maxilla) was very high at 90.8 per cent. Concordance for erosion was 86 per cent in MZ twin pairs and 81 per cent in DZ twin pairs, a difference that was not statistically significant.

Occlusion

MZ twin pairs showed higher concordances for occlusal relationships in this study than DZ twin pairs.

Fig 3. Diagram showing prevalence of discordance for preferred grinding side in MZ and DZ twin pairs. (i) 30.4 per cent of MZ twin pairs were discordant for preferred grinding side (and thus displayed mirror imaging for grinding side preference). (ii) 14 per cent of DZ twin pairs were discordant for preferred grinding side. The difference between (i) and (ii) was statistically significant at $p<0.05$.

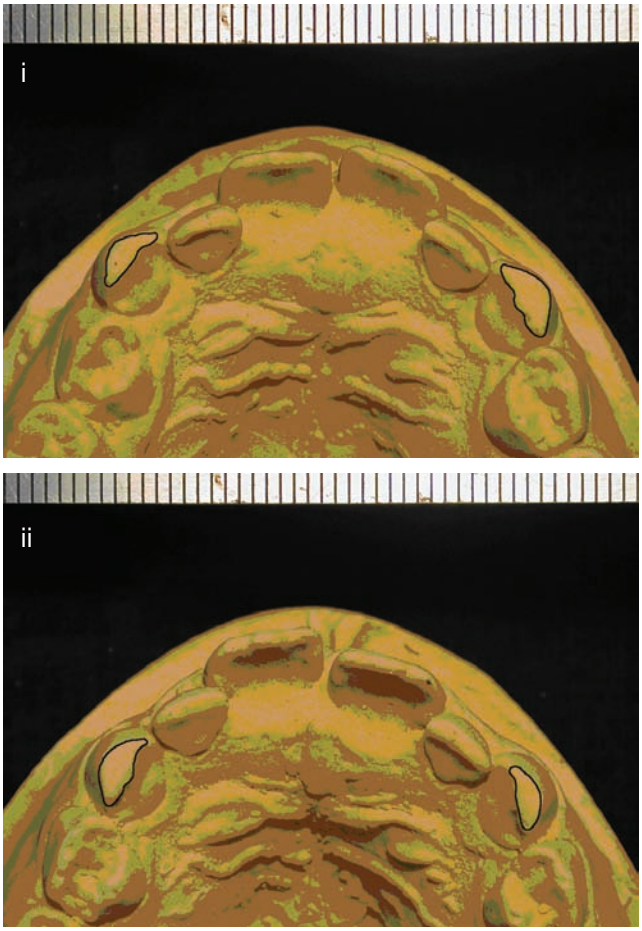

Fig 4. Photographs of dental casts of a pair of MZ twins who were discordant for grinding side preference, and also handedness. (i) MZ twin A with left-sided preference for grinding and non-right-handedness. (ii) MZ twin B with right-sided preference for grinding and right-handedness.

However, none of the differences were statistically significant. There was no consistent relationship between having a deviant canine or molar relationship (either class II or III) and having a side preference for grinding, but there was a statistically significant relationship between having a cross-bite and having a side preference for grinding. As a result of this finding, the relationship of cross-bites to other study variables was investigated further. The prevalence of individuals with a cross-bite in our study was only 13.9 per cent, with an even distribution between MZ and DZ groups. However, when data regarding side preference for

Fig 5. Diagram showing prevalence of consistent discordance for handedness and grinding side preference in MZ and DZ twin pairs. (i) 7.5 per cent of MZ twin pairs were discordant for both handedness and grinding side (and so showed consistent lateralization and consistent mirror imaging for both traits). (ii) 1.8 per cent of DZ twin pairs were discordant for both handedness and grinding side (and so showed consistent lateralization). The difference between MZ and DZ twin pairs was statistically significant at $p<0.05$.

Fig 6. Diagram showing prevalence of concordance for handedness and grinding side preference in MZ and DZ twin pairs. (i) 24.5 per cent of MZ twin pairs were concordant for handedness and side preference. (ii) 28.4 per cent of DZ twin pairs were concordant for handedness and side preference.

grinding were re-analysed, excluding individuals with a cross-bite, there was no change in the pattern of results.

DISCUSSION

Prevalence of tooth grinding

Tooth grinding in young twins appears to be a universal phenomenon, occurring regardless of gender or zygosity. The higher prevalence of grinding recorded for children in this study compared with estimates for adults and children reported in earlier studies is most likely due to the inconsistent and often inaccurate measurement of the phenomenon in previous investigations. We believe that assessing faceting on canine tips is the best way to assess tooth grinding retrospectively given that canine tips are not involved in mastication, and that facet assessment is more reliable and objective than self-report of the grinding activity. Because all of the twins in our study showed evidence of tooth grinding, comparisons between MZ and DZ twin pairs were uninformative in relation to determining whether genetic factors were involved. Different study design, in terms of both methodology and analysis of data, are needed to clarify this interesting topic.

The relatively thin nature of enamel on primary teeth compared with that on permanent teeth[14] predisposes the former to dentine exposure through attrition during their relatively short time in the oral cavity. Frequent intake of erosive foodstuffs can also accelerate tooth wear. An association between erosion (or more correctly, corrosion) and large faceting on canine tips was noted in this study. Thus, while we believe that almost every person experiences grinding episodes at some stage of their childhood, the presence and size of the faceting are not exclusively a result of the frequency and magnitude of grinding. These features are merely evidence of grinding episode(s) that have occurred in the past, together with the superimposed effects of erosion.

How did occlusal factors affect results?

Of the five occlusal relationships measured (molar and canine relationship, overbite, overjet, and cross-bite), only the presence of a cross-bite was significantly associated with a side preference for wear facet production. This is to be expected given that the presence of a cross-bite changes the bucco-lingual relationship of teeth, often leading to closer apposition of canine tips during non-extreme lateral movements (i.e., chewing). Only 13.6 per cent of the sample had a cross-bite, however, and when these individuals were excluded from the statistical analysis, the pattern and interpretation of results was not changed.

Prevalence of non-right-handedness

The frequency of NRH individuals in our sample was 20.3 per cent, which is higher than estimates of 10–12 per cent reported for the general population,[12] and supports previous reports of a higher prevalence of NRH amongst twins.[10,11,15] Of the MZ twins, 23.1 per cent were NRH, compared with 17 per cent of DZ twins. This difference was not statistically significant but it is interesting to note that MZ twins, who are documented to have shorter gestation times and increased birth trauma,[16] tend to show NRH more often than DZ twins. Levy and Gur[16] hypothesized that some cases of left handedness and lateral preference in their study are due to birth trauma. This is one of several hypotheses explaining the aetiology of handedness and cerebral lateralization.

Discordance of handedness and tooth grinding side preference in co-twins

Discordance for handedness within co-twins (Fig 1) differed very little between MZ and DZ twin pairs. This result supports the findings of Dempsey and colleaugues[10] who noted that the different twinning events probably have little to do with determining the handedness and overall laterality of twins. However, significantly more MZ twin pairs were discordant for grinding side preference than DZ twin pairs. In other words, MZ twin pairs showed mirror imaging for grinding side preference significantly more often than DZ twins pairs (Fig 3). This finding suggests that developmental factors associated with the determination of body symmetry may have some influence (otherwise MZ twins would be expected to have identical laterality for grinding side preference). There is some indication that monochorionic MZ twin pairs, who develop between 6 to 9 days postconception, when the body appears to be developing its symmetry, may be more likely to develop mirror imaging (MI).[17] Further studies are planned to explore this possible association between chorion type in MZ co-twins and MI for tooth grinding.

Association between handedness and tooth grinding side preference

The frequency of right-sided preference for grinding was not comparable to the frequency of RH (approximately one-third of the sample preferred their right side for grinding, while 79.7 per cent of the sample were RH). This would suggest that the two lateralized traits are determined or influenced separately.

Are right-handers more lateralized than left-handers?

RH individuals tended to show a higher frequency of grinding side preference (either left or right) compared with NRH individuals, although the result was not

statistically significant. Keles *et al.*[18] found that RHs were consistently asymmetrical facially, the left side of the face being larger than the right as a result of greater development of their dominant left cerebral hemisphere. However, the same was not true for NRHs, who displayed significantly less facial asymmetry (more symmetry), hypothesized to result from equal development of their cerebral hemispheres and consequent ambilaterality. The tendency for RH individuals to display a higher frequency of grinding side preference (regardless of the side) in our study is consistent with Keles' findings, and further investigations into the relationship between facial symmetry, bruxing side preference, and handedness would appear to be warranted. The fact that certain facial asymmetries may be associated with asymmetrical occlusions that could result in asymmetrical wear faceting on canine tips cannot be ignored, however, and would complicate such investigations.

CONCLUSION

Tooth grinding in children appears to occur universally at some stage(s) of their development, and seems to have a developmentally lateralized component. The significantly higher discordance for grinding side preference in MZ twin pairs than DZ twin pairs strongly suggests that any "bruxing centre" in the brain would be affected during the determination of body symmetry in early embryological development. Handedness and grinding side preference, however, are not obviously associated in individuals. There were some examples of MZ twin pairs exhibiting consistent discordance for handedness and grinding side preference, thus demonstrating consistent mirror imaging for these traits. Taking inspiration from Gibbs *et al.*,[19] the authors intend to follow up the same twins in the future to investigate whether their preferred grinding side changes from primary to permanent dentitions, as the chewing cycle direction changes from the primary to permanent dentitions. This may shed some more light on the existence and location(s) of a "bruxing centre" in the brain.

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