Size and Shape Modification of Molars in Children with Down Syndrome

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INTRODUCTION

The permanent molars of individuals with Down syndrome (DS) display a significant decrease in intercusp distances (Prahl-Anderson and Oerlemans 1976; Townsend, 1986). Peretz et al. (1996) showed that these differences were chiefly due to the altered position of the disto-lingual cusp and developed a multivariate probability model for DS and normal individuals.

The general decrease in the intercusp distances of maxillary molars in DS individuals suggests a disturbance in the early stage of formation of the permanent teeth. The change in shape was considered to occur in a late stage of crown formation, and is mainly expressed in reduced growth of the distolingual cusp. In the lower permanent molar, Brown and Townsend (1984) found that the lower permanent molar of DS individuals also showed reduced intercuspal distances and shape changes, with the distal cusps most affected.

This study was conducted in order to examine differences between the upper and lower molars of DS individuals with respect to the severity of the changes observed. We measured the intercusp distances and angles of the left mandibular first permanent molars in individuals with DS, and in a control group and developed a multivariate probability model for DS and normal individuals, which was compared to the model previously carried out for the first maxillary molar.

METHODS

All intercuspal distances and angles of 25 permanent mandibular first molar teeth of DS children (14 boys, 11 girls aged 7-14 years) and 30 permanent mandibular first permanent molars of normal children (12 boys, 18 girls aged 10-14) were measured from dental casts, taken in the course of routine treatment.

A video camera, monitor, and a computer with an image analyzer program were used for the measurements. Each tooth was analyzed separately. The casts were put on a wooden plate and adjusted to be parallel to the plate and perpendicular to the camera. The cusp tips, reflected by the highest points, were then marked with a graphite pencil. The images of the occlusal surfaces of the teeth were then transferred to the monitor on which the variables were measured with the image analyzer program. All intercusp distances were significantly smaller in the DS group.

Wilcoxon nonparametric test was used for univariate comparisons of the groups. Significance level was chosen at 0.05.

RESULTS

All teeth in both groups displayed five cusps. All intercusp distances were significantly smaller in the DS group (Table 1). Significant differences between DS and normals were found in three angles: the d-mb-dl angle was smaller than in normals, the mb-d-dl angle was higher in DS, and the mb-dl-d angle was smaller in DS. Stepwise logistic regression, applied to all intercusp distances was used to design a multivariate probability model for DS and normals.

Table 1. Means and SD of variables on the mandibular teeth (mm for intercusp distances).

	Down (n=25)	Normal (n=30)
Distance		
mb-db	4.26 ± 0.44	4.60 ± 0.54 *
mb-d	7.02 ± 0.45	7.69 ± 0.60 *
mb-dl	6.90 ± 0.57	8.00 ± 0.54 *
mb-ml	4.66 ± 0.46	5.04 ± 0.48 *
db-d	3.14 ± 0.45	3.39 ± 0.41 *
db-dl	5.06 ± 0.54	5.69 ± 0.42 *
db-ml	6.43 ± 0.56	6.94 ± 0.62 *
d-dl	3.80 ± 0.56	4.65 ± 0.44 *
d-ml	7.48 ± 0.55	8.36 ± 0.56 *
dl-ml	4.92 ± 0.42	5.68 ± 0.51 *
Angle		
db-mb-ml°	91.86 ± 4.95	92.15 ± 6.12
mb-db-ml°	46.37 ± 3.34	46.47 ± 3.19
mb-ml-db°	41.76 ± 4.79	41.37 ± 4.51
d-mb-db°	31.52 ± 3.98	34.37 ± 3.73*
mb-d-dl°	76.22 ± 6.10	69.00 ± 5.12*
mb-dl-d°	72.26 ± 4.53	76.64 ± 5.55*

* $P < 0.05$, Wilcoxon test.

A model based on only two intercusp distance (mb-dl and mb-db), proved sufficient to discriminate between the teeth of DS and the normal population ($p = 0.0001$). Thus, the probability for DS in the lower molar is as follows:

$$p\,(DS) = e^{30.6-5.6(mb\text{-}dl)+25(mb\text{-}db)} \,/\, 1+ e^{30.6-5.6(mb\text{-}dl)+25(mb\text{-}db)}.$$

The probability for DS is higher when mb-db is relatively higher in the mb-db/mb-dl ratio. The scaled model shows that for low values of mb-dl (< 7.0 mm), the probability for DS is high. For values of mb-dl (> 7.7 mm), the probability of DS is very low. In the "grey zone" (mb-dl distances between 7.2 and 7.6 mm), the probability for DS is proportional to the mb-db distance (Figure 1a).

DISCUSSION

The opposite signs entered into the model, show that both size and shape are affected. This is reflected in the univariate analyses, that show significant differences in both intercusp distances and angles between the cusps of DS and normal individuals. The scaled model (Figure 1a) demonstrates that these differences are most marked in the disto-lingual cusp of the lower tooth.

Comparison of the formula developed here with that previously reported for the upper molar (Peretz et al., 1996) suggests that the size and shape changes found in lower and upper molars of DS individuals are very similar, with the distal cusps most affected in both teeth. The probability model for the upper molar was as follows:

$$p\ (DS) = e^{20.15-4.53(mb\text{-}dl)+2.98(mb\text{-}ml)} \ / \ 1+ e^{20.15-4.53(mb\text{-}dl)+2.98(mb\text{-}ml)}$$

The scaled model for the upper molar shows that for low values of mb-dl (< 7.0 mm) in the maxillary molars, the probability for DS is high. For higher values of mb-dl (> 9.2 mm), the probability of DS is very low. In the 'grey zone', (mb-dl distances between 7 and 9.2 mm), the probability for DS is proportional to the mb-ml distance (Figure 1b).

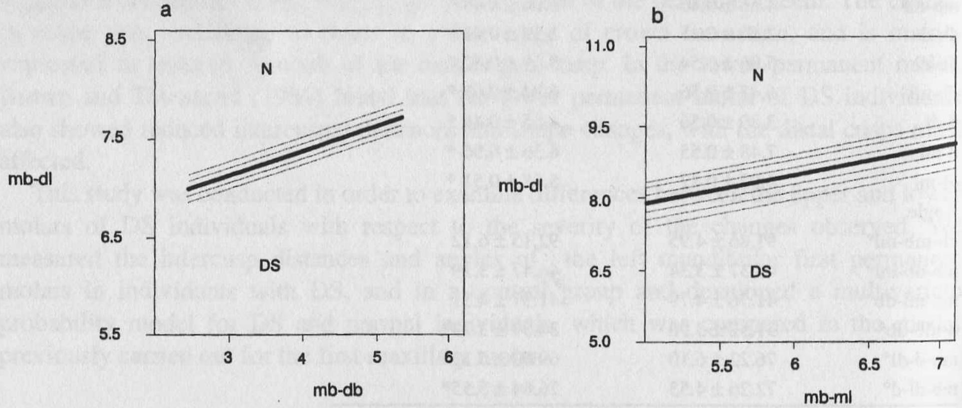

Fig. 1. The scaled models for the upper molar (a), and the lower molar (b). The dotted lines represent the 'grey zones'.

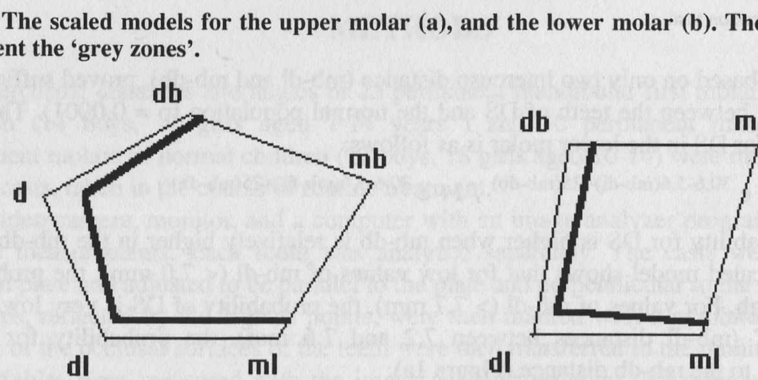

Fig. 2. Superimposition of the cusp tip patterns of a mandibular molar (a) and a maxillary molar (b) of the Down syndrome (DS) and the normal groups using the mb-ml line as an anchor. The heavy lines represent the DS group.

As for the shape of the crowns, it seems that the expression of the syndrome in the upper and lower molars is similar in both, the decreased intercusp distances and in the distal cusps closer to the mesial cusps (Figure 2).

The growth insult in molar formation can be explained by a general slowing down of the mitotic cycle and rate of cell proliferation, resulting in growth retardation in the cells of the inner enamel epithelium of DS tooth germs (Mitwoch, 1972). The fact that it is mainly expressed in the distal portion of the tooth supports the hypothesis of Brown and Townsend (1984). It seems that in DS individuals, the change in size in both the mandibular and maxillary first molars occurs at an early stage, while the change in shape reflects the accumulated effects of continued growth retardation.

The model provides a reliable tool for predicting the probability for Down syndrome from the morphology of mandibular and maxillary molars that may prove of value in other studies of growth defects.

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