European Journal of Orthodontics 21 (1999) 49–56

The length and eruption rates of incisor teeth in rats after one or more of them had been unimpeded

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SUMMARY The eruption rate and length of all four incisor teeth in rats were measured under ether anaesthesia by recording the position of marks on their labial surfaces at 2-day intervals, using calibrated graticules in microscope eyepieces. The rats were divided into four groups and either a lower, an upper, both a lower and an upper, or no incisors were unimpeded. This paper describes the changes when the unimpeded incisors returned to the occlusion. Neither the unimpeded nor the impeded incisors simply returned to control values immediately the period of unimpeded eruption ended, but showed transient changes in their lengths and eruption rates. The results confirm that eruption rates are determined by the sum of the lengths of the lower and upper incisors, rather than by their own lengths, with longer teeth erupting more slowly. Specifically, restoring the bevel to the incisors did not slow their eruption below normal impeded rates. The slowing of the eruption of the longer of two adjacent incisors was related to the length differences of the incisors in the same jaw, not to the sum of the differences in both jaws. Contact with the contralateral incisor in the opposite jaw slowed the eruption of an incisor more than contact with the ipsilateral incisor.

Introduction

Teeth erupt independently of one another, but form a continuous surface in the mouth, the occlusal plane. If teeth are missing or removed, the teeth in the other jaw may erupt beyond the occlusal plane, suggesting that biting on teeth inhibits eruption and is responsible for the formation of the plane. However, it is not known how function stops eruption. The continuous eruption of the incisors of rats is affected by eruption in that they erupt more rapidly when they are shortened to stop them being bitten upon (unimpeded) than when they are not shortened (impeded; Bryer, 1957) and may be an appropriate model for studying this aspect of eruption. When one or more incisors of rats are unimpeded, the function of the other incisors is altered, changing their lengths and eruption rates (Ness, 1956, 1965; Chiba *et al.*, 1968; Burn-Murdoch, 1995). The changes that occur when the unimpeded incisors return to the occlusion have been less well described (Ness, 1956, 1965; Chiba *et al.*, 1968); for example, none of the studies made any measurements on the upper incisors. This investigation was undertaken to describe the changes when previously unimpeded incisors return to the occlusion.

Earlier studies have found that relationships between the length of the incisors and their eruption rates exist, but disagreed over the precise nature of the relationship. Taylor and Butcher (1951) found that shorter incisors erupted more rapidly than longer ones and attributed this to the shorter incisors being unimpeded for some of the time. Michaeli *et al.* (1974) suggested that occlusal contact stimulated the eruption of short incisors and inhibited that of long incisors. Burn-Murdoch (1995) reported that it was the sum of the lengths of the lower and upper incisors that determined eruption rates, with the eruption of short incisors being inhibited less than the eruption of long incisors. He also reported that the longer of two adjacent incisors erupted less rapidly than its neighbour. The difference in eruption rates was correlated with the difference in lengths, but when the correlation was extrapolated to zero length difference, there was still a difference in eruption rates. The results of the present study provide further information about the relationship between tooth length and eruption rate, as well as trying to resolve the discrepancies between earlier studies.

Materials and methods

The eruption rate and length of all four incisors in rats were measured by making marks on the labial surfaces of the incisors and recording their positions at 2-day intervals, using calibrated graticules in microscope eyepieces and the gingival margins of the impeded incisors as the reference points. All procedures were performed under ether anaesthesia. There were four groups of seven or eight male Wistar rats each, initial weights 305–385 g, fed on standard laboratory food that was ground to a powder. All the groups were treated identically until day 10, when either the lower right incisor (group L), the upper right incisor (group U), both the lower and upper right incisors (group B) or no incisors (group N) were unimpeded until day 20, the last shortening occurring on day 18. The experiment ended on day 40. Data analysis was by Fisher's protected least significant difference test. Correlations were assessed by linear least squares methods and analysis of variance of reductions in residual sums of squares (Mason *et al.*, 1989; Snedecor and Cochran, 1989). The results are given as the mean ± 1 SD and $P < 0.05$ was taken as being statistically significant. This paper describes the changes during days 20–30 when the unimpeded incisors were returning to the occlusion The results during the period of unimpeded eruption have been described in an earlier paper (Burn-Murdoch, 1995) which contains more detail of the methods.

Results

There were no significant differences between the groups in the weights of the rats at any stage of the experiment, but the weight gain from days 20 to 30 was signficantly greater in group L than N. There were no significant differences in the eruption rates or lengths of the incisors during the initial control period, days 0–10, or the final one, days 30–40, except that when means for days 30–40 were taken, the eruption of the lower left and upper right incisors was slower in group B than group N. These differences were not significant when averages for the two lower or two upper incisors were taken.

The eruption rates of the incisors over days 20–30 are given in Table 1 and their lengths in Table 2. These data have been given in full; for brevity, some details of derived values in subsequent analyses have been omitted. In analysing the results certain patterns can be seen. The lower left incisor in groups U and B, in which an upper incisor had been unimpeded, became longer and erupted more slowly than in groups N and L. The upper incisors that had been impeded in groups L and B during days 10–20 were longer than in group N on day 20 and erupted more slowly than group N until they had returned to control lengths. Incisors that had been unimpeded became transiently longer and erupted more slowly than the incisors in group N or the adjacent impeded incisor. In groups L and U, there had been left and right impeded incisors in one jaw opposed by only a left one in the other jaw during days 10–20; after day 20 these right impeded incisors became temporarily shorter and faster than the adjacent incisor.

The relationship between tooth length and eruption rate

To compare lengths with eruption rates, the average of the lengths for days 20 and 22 was compared with the eruption rate for days 20–22; the other days were treated similarly. Taking all four teeth and five periods together, there were 50 comparisons between the groups where there were significant differences for both the lengths and eruption rates. In 41 of these comparisons the longer tooth erupted more slowly, which was significantly different ($P < 0.01$, the Chi-squared test) from the 25:25 ratio, that would be expected if length and eruption rate were

Table 1 The eruption rates of the incisors.

Days	Neither (7)	Lower (7)	Upper (8)	Both (8)
Upper right incisor				
20–22	0.40 ± 0.09 LUB	0.23 ± 0.06 NUB	0.53 ± 0.06 NLB	0.65 ± 0.09 NLU
22–24	0.43 ± 0.08 L	0.25 ± 0.11 NUB	0.41 ± 0.12 L	0.44 ± 0.13 L
24–26	0.42 ± 0.07 LU	0.35 ± 0.07 N	0.28 ± 0.06 NB	0.37 ± 0.08 U
26–28	0.35 ± 0.06 LUB	0.26 ± 0.05 NU	0.20 ± 0.08 NLB	0.27 ± 0.10 NU
28–30	0.38 ± 0.04 UB	0.31 ± 0.03 B	0.28 ± 0.10 N	0.24 ± 0.03 NL
Upper left incisor				
20–22	0.33 ± 0.10	0.24 ± 0.11	0.34 ± 0.06	0.27 ± 0.10
22–24	0.43 ± 0.06 LUB	0.21 ± 0.08 NUB	0.37 ± 0.07 NL	0.33 ± 0.10 NL
24–26	0.32 ± 0.06 UB	0.26 ± 0.07 UB	0.47 ± 0.07 NL	0.41 ± 0.07 NL
26–28	0.40 ± 0.06 LU*B*	0.22 ± 0.03 NUB	0.32 ± 0.05 NL	0.35 ± 0.06 *N*L
28–30	0.37 ± 0.10 L*B*	0.27 ± 0.05 NU	0.36 ± 0.06 L	0.31 ± 0.12 *N*
Lower right incisor				
20–22	0.54 ± 0.23 LB	0.81 ± 0.09 NUB	0.48 ± 0.20 LB	1.06 ± 0.13 NLU
22–24	0.59 ± 0.14 *LB*	0.47 ± 0.04 *N*	0.55 ± 0.14	0.50 ± 0.14 *N*
24–26	0.45 ± 0.07 *LUB*	0.41 ± 0.05 *N*U	0.59 ± 0.15 NLB	0.33 ± 0.13 *N*U
26–28	0.53 ± 0.08 L*U*B	0.33 ± 0.08 NU	0.49 ± 0.08 *N*LB	0.34 ± 0.05 NU
28–30	0.48 ± 0.12 *U*	0.39 ± 0.05	0.38 ± 0.10 *N*	0.37 ± 0.08
Lower left incisor				
20–22	0.60 ± 0.11 LU	0.38 ± 0.06 NB	0.35 ± 0.08 NB	0.65 ± 0.14 LU
22–24	0.53 ± 0.08 *UB*	0.45 ± 0.08	0.43 ± 0.10 *N*	0.43 ± 0.13 *N*
24–26	0.46 ± 0.05 *UB*	0.59 ± 0.11 UB	0.39 ± 0.08 *N*L	0.36 ± 0.20 *N*L
26–28	0.44 ± 0.10 UB	0.46 ± 0.05 UB	0.30 ± 0.09 NL	0.30 ± 0.06 NL
28–30	0.51 ± 0.16 UB	0.44 ± 0.08 U	0.30 ± 0.05 NL	0.36 ± 0.09 N

The results are given as the mean ± 1 standard deviation in mm/day. The groups that were significantly different are indicated by the letters after the standard deviations. Where two or more of the significant differences are given in italics, the mean values for all the days were significantly different, but the results for the individual days were not. The numbers of rats in the groups are given by the names of the groups.

independent. Seven of the nine exceptions disappeared when the sum of the lengths of the lower and upper incisors was used instead of the lengths of the individual incisors, and the other two were associated with marked differences in the lengths of adjacent incisors.

To determine whether the lengths of the individual incisors or the sum of the lower and upper lengths determined eruption rates, the upper and lower incisors were compared over days 24–30, when all the incisors were in occlusion. The average of the eruption rates of the lower left and right incisors was significantly and positively correlated with the average eruption rate of the upper incisors in groups N, L and U, but not B; that is slower lower incisors were associated with slower upper incisors (groups N: $r = 0.50$, $P < 0.05$; L: $r = 0.67$, $P < 0.01$; U: $r = 0.55$, $P < 0.01$; B: $r = 0.05$, NS). The average lengths of the lower incisors were significantly, but negatively correlated with the average length of the upper incisors in group N and the other groups when they were combined; that is, shorter lower incisors were associated with longer upper incisors (groups N: $r = -0.50$, $P < 0.05$; L, U and B combined: $r = -0.25$, $P < 0.05$).

Left–right differences

The difference between the eruption rates of the left and right lower incisors was negatively correlated with the difference in their lengths on days 20–22. The longer incisor was slower and the larger the length difference, the greater

Table 2 The lengths of the incisors.

Days	Neither	Lower	Upper	Both
Upper right incisor				
20	4.34 ± 0.21 L	4.94 ± 0.26 N		
22	4.19 ± 0.27 LUB	4.89 ± 0.29 NUB	3.41 ± 0.19 NL*B*	3.49 ± 0.13 NL*U*
24	4.28 ± 0.18 LU	4.59 ± 0.25 NUB	3.97 ± 0.18 NL*B*	4.13 ± 0.14 L*U*
26	4.29 ± 0.21 LB	4.60 ± 0.18 NUB	4.32 ± 0.14 LB	4.49 ± 0.13 NLU
28	4.24 ± 0.16 LB	4.52 ± 0.18 N	4.37 ± 0.05 B	4.60 ± 0.20 NU
30	4.25 ± 0.18	4.39 ± 0.22	4.31 ± 0.09	4.48 ± 0.16
Upper left incisor				
20	4.41 ± 0.16 LUB	5.00 ± 0.27 NUB	3.94 ± 0.21 NLB	4.67 ± 0.20 NLU
22	4.16 ± 0.28 LB	5.03 ± 0.19 NUB	3.95 ± 0.19 LB	4.43 ± 0.17 NLU
24	4.38 ± 0.26 LU	4.77 ± 0.20 NUB	3.94 ± 0.10 NLB	4.35 ± 0.18 LU
26	4.29 ± 0.16 LU	4.78 ± 0.16 NUB	4.05 ± 0.12 NLB	4.36 ± 0.17 LU
28	4.37 ± 0.13 *LB*	4.60 ± 0.22 *N*U	4.25 ± 0.10 LB	4.49 ± 0.22 *N*U
30	4.33 ± 0.13 *LB*	4.48 ± 0.27 *N*	4.36 ± 0.13	4.58 ± 0.18 *N*
Lower right incisor				
20	8.73 ± 0.48 LUB	7.00 ± 0.23 NUB	9.52 ± 0.48 NLB	6.73 ± 0.23 NLU
22	8.79 ± 0.28 LU	8.30 ± 0.24 NU	9.22 ± 0.20 NLB	8.60 ± 0.31 U
24	8.87 ± 0.26 *U*B	8.70 ± 0.30 U	9.13 ± 0.34 *N*L	9.34 ± 0.20 NL
26	9.06 ± 0.31 *U*	9.11 ± 0.22	9.30 ± 0.10 *N*	9.36 ± 0.25
28	9.22 ± 0.31 *U*	9.25 ± 0.26	9.50 ± 0.22 *N*	9.51 ± 0.28
30	9.09 ± 0.32 UB	9.27 ± 0.37	9.31 ± 0.26 N	9.51 ± 0.26 N
Lower left incisor				
20	8.75 ± 0.48 LUB	8.13 ± 0.30 NU	9.56 ± 0.30 NLB	8.23 ± 0.32 NU
22	8.87 ± 0.30 LU	8.43 ± 0.45 NUB	9.43 ± 0.23 NLB	8.99 ± 0.26 LU
24	8.86 ± 0.36 UB	8.47 ± 0.43 UB	9.43 ± 0.30 NL	9.34 ± 0.33 NL
26	9.04 ± 0.28 UB	9.03 ± 0.32 UB	9.53 ± 0.18 NL	9.52 ± 0.28 NL
28	9.21 ± 0.30 UB	9.16 ± 0.36 UB	9.67 ± 0.22 NL	9.59 ± 0.31 NL
30	9.09 ± 0.28 UB	9.23 ± 0.41	9.36 ± 0.25 N	9.56 ± 0.29 N

The table has the same format as Table 1 except that the results are in mm.

was the difference in eruption rates (r = –0.74, $P < 0.001$). The correlation diverged significantly from linearity ($P < 0.01$) in that the difference in eruption rates showed no further change when the difference in lengths was more than 0.5 mm.

To avoid the non-linear region of the correlation, further analyses were performed on the results of days 24–30 when all four incisors were in occlusion. The correlations between the left–right differences in eruption rates and the left–right length differences for the lower incisors in groups N and L were not significant, but in group L the right incisors were longer and erupted more slowly than the left. The correlations were significant and negative in groups U (r = –0.53, $P < 0.05$) and B (r = –0.46, $P < 0.05$); the corresponding correlations for the upper jaw were also significant in groups U (r = –0.49, $P < 0.05$) and B (r = –0.53, $P < 0.01$). The slopes of the correlations were not significantly different from each other, nor from the corresponding correlations for days 10–20 (Burn-Murdoch, 1995). The correlations did not always pass through the origin and the intercepts on the difference in eruption rate axis are shown in Table 3, where the values are given as left minus right. The difference in lengths of the incisors in the opposite jaw are also given in Table 3 and they are related to the intercept on the difference in eruption rate axis.

Table 3 Intercepts on the difference in eruption rate axis of the correlations of the difference in eruption rates of adjacent incisors against their difference in lengths.

	Intercept (mm/day) Mean ± SD	Length difference in the other jaw (mm)		
		P	Mean ± SD	P
Days 10–20				
Lower incisors	+0.16 ± 0.03	<0.01	+2.40 ± 0.20	<0.001
Upper incisors	+0.10 ± 0.05	<0.05	+2.60 ± 0.20	<0.001
Days 24–30: upper incisors				
Group U	+0.06 ± 0.03		+0.19 ± 0.16	<0.001
Group B	+0.05 ± 0.02	<0.05	+0.07 ± 0.16	<0.05
Days 24–30: lower incisors				
Group U	–0.07 ± 0.04	<0.01*	–0.09 ± 0.15	<0.05
Group B	+0.03 ± 0.02		+0.02 ± 0.20	

All values are given as left minus right and as the mean ± 1 standard deviation. The asterisk by a P value indicates that the values for groups U and B are significantly different from each other though neither value is significantly different from zero.

To see whether the length difference in one jaw or the sum of the lower and upper length differences determined eruption rates, the upper and lower incisors were compared over days 24–30. The difference in the lengths of the two lower incisors was negatively and significantly correlated with the difference in the lengths of the two upper incisors in group N and in the other groups when they were combined; that is, when the left incisor was longer than the right in one jaw, the right incisor would be the longer tooth in the other jaw (combined groups: $r = –0.47$, $P < 0.001$). The corresponding correlation for the eruption rates was also significant and negative when the groups were combined ($r = –0.45$, $P < 0.001$). When the difference in length of the two incisors in the lower jaw was added to the length difference in the upper jaw, the sum of the length differences was not correlated with the difference in the eruption rates of adjacent incisors in either jaw.

The restoration of the bevel edge

The incisors that had been unimpeded became longer than the adjacent impeded incisor. All the lower unimpeded incisors had a sharp bevel edge before they became longer than their neighbours. Three of the upper incisors in group B were sharp before they were as long as the adjacent incisor and three in U were still blunt when they were longer than the other tooth. The other incisors went from being blunt and shorter to sharp and longer than their neighbour between consecutive measurements.

Discussion

Earlier investigations of the return of unimpeded incisors to the occlusion have been performed only on animals corresponding to group L in this study and measurements were made on only the lower incisors. The only study in rats (Chiba *et al.*, 1968) showed that both the impeded and unimpeded incisors were temporarily slowed, which was confirmed in the present study.

There is little evidence that the results of the present study were systemically mediated. There were no significant differences between the weights of the groups at any stage of the experiment; though the weight gain over days 20–30 was greater in L than N, the difference was less than 1 g/day and there were no significant differences between the other groups. The similarity of the unimpeded eruption rates in the different groups during days 10–20, discussed

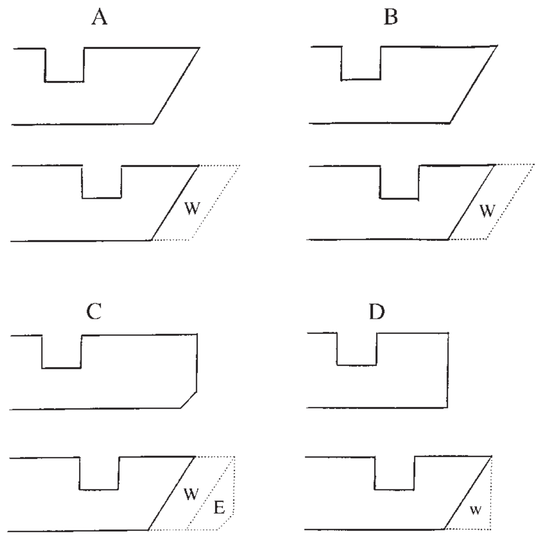

Figure 1 The diagrams represent rat incisors with a notch on their labial surfaces. Each pair represents an incisor on day N (above) and on day $N + 2$ (beneath), with the amount of tooth that was worn away in the 2 days indicated by dashed lines. A is a normal impeded incisor and the area W shows how much tooth is worn away between the 2 days. C shows a previously unimpeded incisor which did not have a sharp bevel edge before it was as long as the impeded incisor; the amount of tooth worn away during the 2 days is increased by the area E. B is a repeat of A for comparison with D which represents a previously unimpeded incisor which becomes sharp before it is as long as the impeded incisor; the amount of tooth worn away from the unimpeded incisor during the 2 days is the area w which is smaller than W.

by Burn-Murdoch (1995), supports the lack of systemically mediated effects.

The restoration of the bevel edge

The effect of restoring the bevel edge on the amount of tooth worn away is shown in Figure 1. If the bevel is restored before the unimpeded incisor is as long as the impeded incisor, less material will be worn away from the unimpeded than from an impeded incisor that erupts the same distance. Conversely, if the bevel is restored when the unimpeded incisor is longer than the impeded incisor, more material will be removed from the unimpeded incisor. The lower unimpeded incisors were sharp before they were longer than their neighbours so the restoration of the bevel did not slow their eruption. Though the restoration of the bevel of the upper incisors could have contributed to the slowing of some, but not all, of the upper incisors, the presence of teeth where the restoration of the bevel could not have contributed to the slowing makes it unlikely that the restoration of the bevel is a major factor.

The causes of the length changes

Longer incisors erupted more slowly than shorter teeth; the differences in eruption did not produce the differences in length because faster eruption would produce longer teeth. Some of the length changes may be due to the difficulty of wearing away two incisors in one jaw with only one impeded incisor in the other jaw; this explains the long lower incisors in group U, which were also long during days 10–20 (Burn-Murdoch, 1995), and the lengthening of the lower incisors in group B because the lower unimpeded incisor returned to the occlusion before the upper one. The upper impeded incisors were long in groups L and B on day 20 because of the shortening of the lower impeded incisor during the period of unimpeded eruption (Burn-Murdoch, 1995); the upper incisors were reduced to control values earlier in group B than group L because there were two incisors to shorten in group L but one in group B.

It is unclear why the incisors that had been unimpeded, became longer than control teeth. Where there had been left and right impeded incisors in one jaw and only a left one in the other jaw, the unopposed right incisors became shorter than their neighbours when the unimpeded incisors returned to the occlusion. The shortening might have been due to the lengthening of the previously unimpeded incisor if the incisors made contact mainly with the ipsilateral tooth in the opposite jaw, but the differences between left and right incisors, to be discussed below, suggest that each incisor in one jaw contacts both incisors in the other jaw.

The effect of tooth length on eruption rates

Burn-Murdoch (1995) proposed that eruption rates were affected by the sum of the lengths of the lower and upper incisors; conversely, Taylor and Butcher (1951), and Michaeli *et al*. (1974) had proposed that the length of individual incisors determined eruption rates. However, the results of both those papers are consistent with the sum of the lengths of the lower and upper incisors being the important factor, as discussed by Burn-Murdoch (1995).

The present study supports the hypothesis that the sum of the lower and upper lengths is the important factor because, after day 24 when all the incisors were in occlusion, longer teeth in one jaw were associated with shorter teeth in the other jaw. If the length of the individual incisors were the factor affecting eruption rates, slower eruption rates in one jaw would be associated with more rapid eruption in the other jaw, but the opposite was found: slow incisors in one jaw were associated with slow incisors in the other jaw.

Turning to how the length of the incisors affects eruption rates, the difference between the unimpeded and impeded eruption rates is much larger than the effect on the impeded eruption rate of changes in the consistency of the diet (e.g. Taylor and Butcher, 1951) so eruption rates are determined by the sharpening of incisors against each other, not by eating. Taylor and Butcher (1951) suggested that shorter incisors erupt more rapidly because the teeth are unimpeded for part of the time, but this does not explain the slow eruption of longer teeth. The effect of tooth length on eruption rates could be due to sharpening slowing longer incisors more than shorter ones, because of changes in the magnitude or angle of the forces applied to the tooth or the leverage exerted by the forces; alternatively, longer incisors may need more sharpening than shorter ones to remove the same amount of tooth, for similar reasons. It is not known whether the eruption is slowed because the forces promoting eruption are reduced or because the resistance to eruption exerted by the surrounding tissues is increased; both could contribute to the slowing.

The experiments reported here concern short-term changes and it may not be appropriate to extrapolate the findings to those occurring with age. It is occlusal forces that slow eruption and the lengths of the teeth alter either the magnitude or the effectiveness of the forces. With age, other factors, such as an increase in the separation of the jaws and in the size of the muscles of mastication, may have an effect on the forces exerted on the teeth.

Differences between adjacent incisors

When there was a difference between the length of adjacent incisors, the longer incisor erupted more slowly except in group N, it is likely that the longer incisor of a pair is exposed to greater forces during biting. If the left incisor was longer and slower than the right in one jaw, the right incisor tended to be longer and slower in the other jaw. There was no correlation between the difference in erupton rates of adjacent incisors and the sum of the length differences in both jaws. Therefore, the difference between the eruption rates of left and right incisors in one jaw was due to the difference in lengths in the same jaw, not to the sum of the length differences in both jaws. This could have arisen if one incisor made contact with both incisors in the opposite jaw, but the sum of the length differences in the two jaws would have determined the difference in eruption rates if contact had been made between only ipsilateral incisors. One impeded incisor would have had to make contact with both incisors in the opposite jaw in groups L and U during days 10–20, and in group B later on because the lower unimpeded incisors returned to the occlusion before the uppers, but the design of the experiment never forced group N to make contact across the midline.

During days 24–30, the differences between the eruption rates of the adjacent incisors were often correlated with the differences between their lengths. It might be thought that when the correlations were extrapolated to where there was no difference in lengths, there would be no difference in eruption rates, but this was not so. Often when there was no difference in length, there was still a difference in eruption rates. The difference in eruption rates is called an intercept on the difference in eruption rate axis.

The intercept was related to which incisor was longer in the opposite jaw (Table 3). When there was no difference between the lengths of adjacent incisors, it was the tooth which was ipsilateral to the longer teeth in the opposite jaw that erupted more rapidly, contrary to what would be expected on simple mechanical grounds. Consequently, contact with the contralateral incisor in the opposite jaw must slow eruption more than contact with the ipsilateral incisor. In normal function the length of tooth worn away equals the eruption rate so the same length of tooth worn away will slow the eruption more when contralateral incisors are sharpened against each other than when ipsilateral incisors are used. This may be due to either the effectiveness of forces at slowing eruption varying with their direction, or sharpening contralateral incisors needing greater or more prolonged forces than sharpening ipsilateral incisors.

Implications for unimpeded eruption rates

The failure of length differences greater than 0.5 mm to increase further the difference in eruption rates may be because the shorter incisor is fully unimpeded at that point, but wear facets were seen on the end of unimpeded incisors when the length difference was greater than this (Burn-Murdoch, 1995). The discrepancy may be because the faster was an unimpeded incisor and the sooner it returned to the occlusion, the greater would be the forces applied to it (Ness, 1956). A faster underlying eruption combined with a greater slowing of the eruption could make the eruption independent of length. Also, shorter impeded incisors erupt more rapidly than longer ones so, as the length of tooth worn away equals the eruption rate in the steady state, wear is less effective at slowing eruption in shorter incisors; therefore, the small amount of tooth worn away to produce wear facets on unimpeded incisors may have negligible effects on eruption.

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Acknowledgements

I am grateful for financial support for this experiment from the Dental Funds Committee of Guy's Hospital Dental School.

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