Occurrence of vertical bone defects in dentally aware individuals

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A vertical (angular) defect is a radiographic diagnostic phenomenon of severe periodontal destruction. The objective of the present study was to investigate the prevalence and severity of vertical defects in a population of dentally aware individuals at 2 different points in time, 1982 and 1992. Intra-oral radiographs of 251 individuals in 1982 and 247 individuals in 1992 in the age range 21–70 years were assessed with regard to presence or absence of vertical defects adjacent to a maximum of 28 teeth per person. A vertical bone defect was defined as a one-sided bone resorption of the interdental marginal bone $\geq$2 mm that had a typical angulation towards either the mesial or distal aspect of the root. The prevalence of vertical defects in 1982 was 38% increasing from 11% in age 21–30 years to 64% in age 51–70 years, and 27% in 1992 increasing from 7% to 47% in the same age groups, respectively. The number of defects per person increased with age. The majority of affected individuals had 1–2 defects and only about 5% were severely affected. Vertical defects were more common in the posterior as compared to the anterior region of the dentition and the distribution of defects within the maxilla as well as the mandible typically revealed a right-hand to left-hand side symmetry. Vertical defects seem to be a rare phenomenon in dentally aware individuals. In particular, multiple defects were observed only in a minor proportion. Both prevalence and severity increased with age. □ *Age; bone; periodontitis; radiography; vertical defect*

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Horizontal bone loss is the most common pattern of interdental bone resorption in periodontal disease. Occasionally, however, specific resorption patterns occur, such as osseous craters and infrabony defects. The radiographic representation of infrabony destruction is commonly referred to as vertical or angular defects. The radiographic appearance of the vertical defects as a structural entity is well recognized and has been described in detail (1–3). A vertical defect is a pathologic phenomenon related to the process of irregular bone resorption seen in advanced forms of periodontal disease. Although vertical defects are considered a sign of progressive or advanced disease, their occurrence in the population has been but little investigated.

According to the limited number of studies available, the occurrence of vertical defects in patients seeking dental care seems to vary between 23% and 61% (4, 5). In the only population study available, a prevalence of 32% was reported (6). Papapanou et al. (7) examining patients seeking dental care and using the tooth as the unit of observation found that 8% of the teeth had a vertical defect. Thus, although the number of studies is limited the variation in the prevalence estimates is considerable. This may be due to differences in the characteristics of study populations, the methods of assessment and/or the definitions of a vertical defect.

The present study aimed at investigating the prevalence and severity of vertical bone defects in a population consisting of dentally aware individuals. In addition, possible changes in prevalence and severity over time were studied. One sample of this population was drawn in 1982 and another in 1992. Particular focus was placed on the influence of age.

Materials and Methods

Study population

The study samples were derived from a previously described population of occupational musicians (8, 9) who were considered 'dentally aware' in 1982 (8) owing to the findings that the vast majority (94%) visited a dentist on a regular basis and brushed their teeth twice daily (87%). The overall mean (SD) Silness & Loe plaque index was 0.86 (0.38) in 1982 and 0.76 (0.36) in 1992 (9). The improvement in plaque index was statistically significant ($P = 0.002$). The sample drawn in 1982 included 264 individuals in the age range 21–70 years and the 1992 sample included 258 individuals in the same range; 101 individuals participated in both samples. Owing to missing or incomplete radiographic data, 13 individuals from the 1982 sample and 11 from the 1992 sample were excluded. Male was the predominating gender, representing 86% and 76%, respectively, of the 1982 and 1992 samples. The distributions by age and gender of the two samples are presented in Table 1. The mean (SD) age was 43.2 (11.2) years in 1982 and 42.3 (12.1) years in 1992. The mean (SD) number of teeth remaining was 26.4 (2.7) in 1982 and 27.1 (1.9) in 1992 (Table 2). The difference was not statistically significant ($P > 0.05$). The study was approved by the local ethics committee of Karolinska Institutet, Stockholm in accordance with the Helsinki Declaration of 1975 and as revised in 1983.

Radiographic assessment

A full set of intraoral radiographs, including 16 periapical and 4 bitewing projections, was available for

Table 1. Distributions of the 1982 and 1992 samples by age and gender

	1982				1992			
Age group	Mean age	Male *n*	Female *n*	Total *n*	Mean age	Male *n*	Female *n*	Total *n*
21–30 years	26.6	33	13	46	27.2	31	14	45
31–40 years	35.9	46	11	57	34.9	59	24	83
41–50 years	45.7	69	4	73	45.6	33	11	44
51–70 years	56.4	69	6	75	57.7	64	11	75
Total	43.2	217	34	251	42.3	187	60	247

each individual. The modified parallel long-distance technique was used. The film was placed in a film-holder as parallel as possible to the long axis of the teeth. The X-ray machines used, operating at 65–70 kVp, were equipped with a rectangular tube giving at least 0.20 m target-to-skin distance. Kodak Ekta Speed film (speed group E) was used. A Mattsson viewer giving 2 times magnification and a light table with good illumination were used for radiographic assessment. A vertical bone defect was defined as a one-sided bone resorption of the interdental marginal bone $\geq$2 mm that had a typical angulation towards either the mesial or distal aspect of the root. In addition, the lamina dura of the affected tooth showed widening (2, 3).

All teeth except 3rd molars were assessed as to the presence or absence of a vertical defect. However, if a 1st or 2nd molar was missing, the 3rd molar of the same quadrant was included.

All radiographs were independently assessed by 2 observers (SN and MB). In the event of disagreement between the examiners, the final decision was taken after a consensus of all authors.

Error of measurement

The reproducibility of the method was estimated following the principle of repeated measurements resulting in an estimate of the precision of the method. The precision (s) was expressed as the standard deviation of a single measurement as found from the relation

$$s = \sqrt{\Sigma d^2/2n}$$

where d connotes the difference between replicates and n the number of the differences. Reproducibility was evaluated in a subsample of 73 individuals of the 1982 sample and 69 individuals of the 1992 sample. The precision was $s = 0.3$ and $s = 0.6$ for the 1982 and 1992 samples, respectively. The error pertaining to the mean was $s_{mean} = 0.02$ and 0.04 in 1982 and 1992, respectively.

Statistics

The severity expressed as the absolute as well as the relative (%) number of proximal sites with a vertical defect was used as the dependent variable. Intra-individual differences between means of various regions of the dentition were tested with the Wilcoxon test of matched pairs. Differences between means of samples were tested with the Mann-Whitney U test. The association between severity and age was tested with Kruskal-Wallis ANOVA on ranks. Ordinal data were tested with the chi square distribution. The data were analyzed using the Statistica (6.0) program. Statistical significance was accepted at $P < 0.05$.

Results

Prevalence

Overall, a total of 222 vertical defects was observed in 1982 and 198 in 1992, corresponding to 1.8% and 1.7%, respectively, of the total number of sites available for determination. The numbers of vertical defects, intact sites, and missing sites of the two samples are presented in Table 3. The prevalence of individuals affected was 38% in 1982 and 27% in 1992, respectively. The prevalence was significantly lower in 1992 (chi square = 7.1, $P = 0.008$). The prevalence increased with increasing age from 11% in age group 21–30 years to 64% in age group 51–70

Table 2. Number of remaining teeth in the 1982 and 1992 samples. Mean (SD) according to age

	1982			1992		
Age group	Range	Mean	(SD)	Range	Mean	(SD)
21–30 years	24–28	27.3	1.19	26–28	27.9	0.39
31–40 years	24–28	27.4	1.19	24–28	27.7	0.74
41–50 years	21–28	26.9	1.54	20–28	27.0	1.67
51–70 years	11–28	24.6	3.99	18–28	25.9	2.66
Total	11–28	26.4	2.71	18–28	27.1	1.90

Table 3. Number (*n*) and percentage (%) of intact sites, sites with a vertical defect, and missing sites based on all single sites in the 1982 and 1992 samples

	1982		1992	
	n	(%)	*n*	(%)
Intact sites	12458	(88.6)	11664	(84.3)
Vertical defects	222	(1.6)	198	(1.4)
Missing sites	1376	(9.8)	1970	(14.2)
Total	14056	(100)	13832	(100)

years in 1982 and from 7% to 47%, respectively, in 1992 (Fig. 1).

Severity

The distributions of individuals by number of vertical defects in 1982 and 1992 are presented in Fig. 2. Among all affected individuals, 72% and 62% in 1982 and 1992, respectively, had a maximum of 2 defects, while 15% and 23% in 1982 and 1992, respectively, exhibited 5 or more defects.

The mean (SD) number of vertical defects per person in 1982 and 1992 was 0.88 (1.63) and 0.76 (1.78), respectively. Expressed as percent of available sites, the mean (SD) was 4.2% (10.4%) and 3.3% (9.2%), respectively. The difference between samples with regard to severity was statistically significant (Mann-Whitney $\mathcal{Z} = 2.5$, $P = 0.012$). The mean (SD) number of defects increased with age from 0.11 (0.32) in age group 21–30 years to 1.89 (2.3) in age group 51–70 years in 1982 and from 0.09 (0.37) to 1.61 (2.65), respectively, in 1992. The increase across age groups was statistically significant in both samples (Kruskal-Wallis $H = 51.3$ and 33.1, respectively, $P = 0.000$). The severity according to age in 1982 and 1992 is illustrated in Figs 3 and 4, respectively.

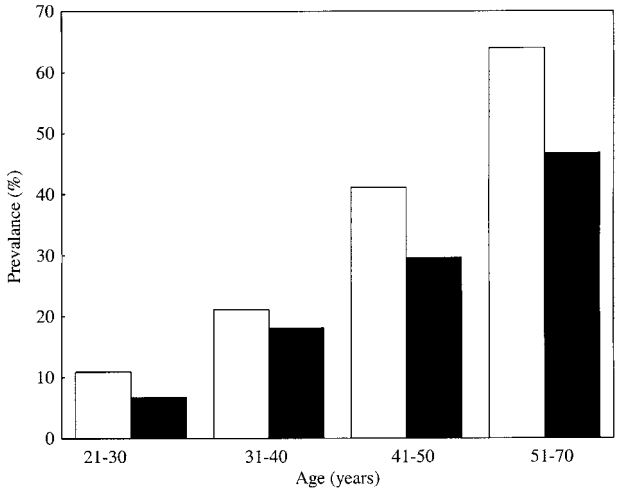

Fig. 1. Age specific prevalence in 1982 and 1992 (□ = 1982; ■ = 1992).

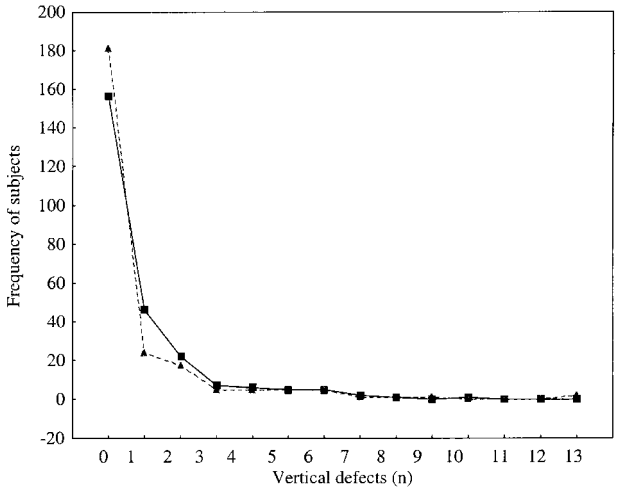

Fig. 2. Distribution of individuals according to numbers of vertical defects in 1982 and 1992 (■ = 1982; ▲ = 1992).

The mean (SD) numbers of defects per person in the anterior and posterior regions of the dentition were 0.16 (0.61) and 0.72 (1.31), respectively, in 1982 and 0.12 (0.47) and 0.64 (1.51), respectively, in 1992. Expressed as percent, the means (SD) of the anterior and posterior regions were 0.8% (3.4%) and 3.4% (7.3%), respectively, in 1982 and 0.6% (2.3%) and 2.7% (7.0%), respectively, in 1992. Irrespective of mode of expression the difference between anterior and posterior regions was statistically significant in both samples (Wilcoxon, $\mathcal{Z} = 6.6$–6.9 and 5.8–6.0, respectively, $P = 0.000$).

The mean (SD) proportions of maxillary and mandibular defects per person were 1.8% (4.2%) and 2.4% (5.9%), respectively, in 1982 and 1.6% (4.5%) and 1.7% (4.5%), respectively, in 1992. The difference was not statistically significant neither in 1982 nor 1992 (Wilcoxon, $\mathcal{Z} = 1.6$ and 0.8, respectively, $P > 0.05$).

The mean (SD) proportions of vertical defects per

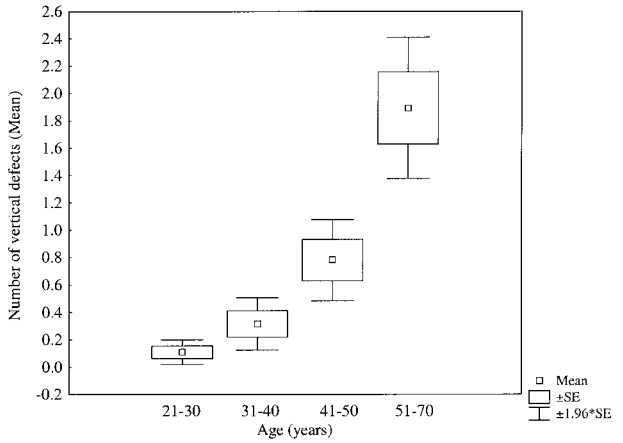

Fig. 3. Mean number of vertical defects per person. Box plots according to age. 1982 population.

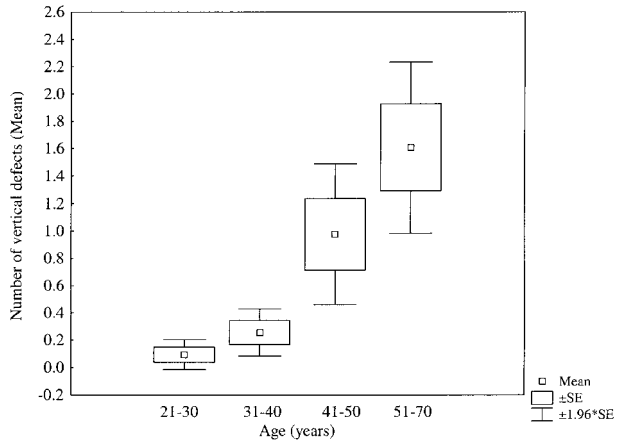

Fig. 4. Mean number of vertical defects per person. Box plots according to age. 1992 population.

person in the right-hand and left-hand sides of the dentition were 2.1% (4.9%) and 2.1% (5.3%), respectively, in 1982 and 1.8% (4.8%) and 1.5% (4.1%), respectively, in 1992. The difference was not statistically significant neither in 1982 nor 1992 (Wilcoxon, $z = 0.7$ and 1.1, respectively, $P > 0.05$). The mean proportions of vertical defects per person according to tooth type and site (mesial and distal) in 1982 and 1992 are shown in Figs 5 and 6, respectively.

Discussion

The aim of the present investigation was to provide information about prevalence and severity of vertical defects in dentally aware people, i.e. individuals with regular dental care habits and a high standard of oral hygiene (8, 9). Although not representative of the Swedish

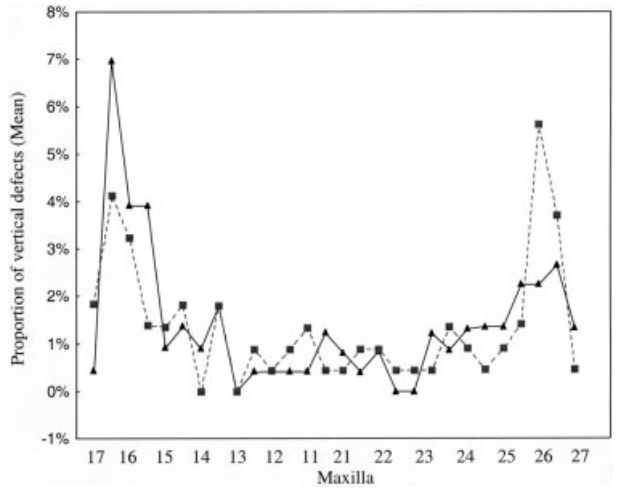

Fig. 5. Mean proportion of vertical defects per person according to tooth and site. The maxilla (■ = 1982; ▲ = 1992).

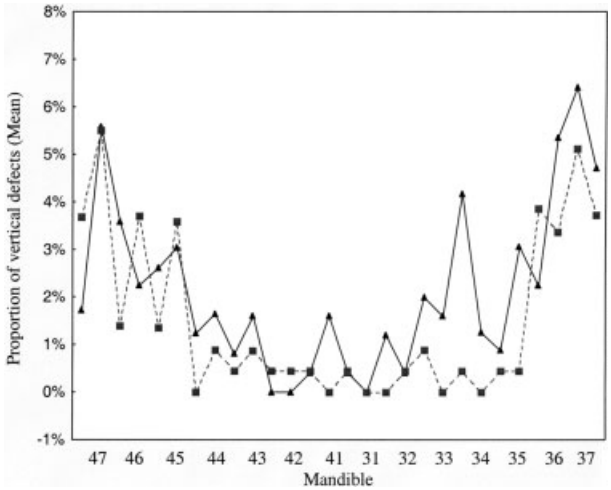

Fig. 6. Mean proportion of vertical defects per person according to tooth and site. The mandible (■ = 1982; ▲ = 1992).

population at large, the present population is considered representative of the middle class, which is a major proportion of the Swedish population. An advantage of utilizing a population of dentally aware people for the study of vertical defects is the circumstance that the number of retained teeth in such individuals can be expected to be high. In previous studies of vertical bone loss the populations studied mostly consisted of patients seeking dental care (4, 5, 7). It can be assumed that the level of tooth retention is lower in dental care seekers than in the present population. Only one previous study concerned a random selection of individuals (6). The level of tooth retention, however, was comparably low also in that study, particularly in older age groups. When the number of teeth is low the estimates of the prevalence and particularly the severity of vertical defects become inaccurate and unreliable. The present study is the first to allow estimates of vertical bone defects based on a high level of tooth retention throughout all age groups. In addition, it is the first study to investigate the phenomenon over time by the comparison of two consecutive cross-sectional samples separated by 10 years.

The overall occurrence of vertical defects in the present population was a rare event. Out of a total of approximately 14,000 tooth sites examined at each of the two time-points, 1.8% and 1.7%, respectively, exhibited the characteristics of a vertical defect according to the definition used, corresponding to a prevalence of 38% in 1982 and 27% in 1992. This is considerably less than that observed in patient populations (7, 10) but comparable to the reported prevalence of 32% in a large scale Swedish population study in 1983 (6). The decrease in prevalence over the 10 years covered by the present investigation was particularly pronounced in the oldest age group and suggests a periodontal health improvement in the population. A feature common to both samples of the present study was the observation that the prevalence

increased with increasing age. The increase across age groups was approximately 6-fold in the 1982 sample (11%–64%) and approximately 7-fold (7%–47%) in 1992. This is in general agreement with previous studies (4, 6, 7).

The distribution of individuals with regard to the frequency of vertical defects was typically skewed to the right, i.e. most individuals were not at all or only slightly affected. Moreover, approximately 60% to 70% of the affected individuals had a maximum of 2 defects and, as a consequence, a minority only was severely affected. The presently found distribution characteristics resemble those reported by others (5, 6).

The severity in terms of mean number of defects per person was on average less than 1.0 both in 1982 and 1992, or expressed as the proportion of affected sites per person approximately 4% in 1982 and approximately 3% in 1992. Only one earlier study has elucidated the severity aspect (6). The severity reported seems to be of the same magnitude as that observed in the present study. These observations suggest that vertical defects are normally a rare phenomenon within the dentition. The relationship between age and increasing severity was highly significant in both samples. The severity followed a similar age pattern in both samples. In the oldest age group, however, a clear decrease was observed over the 10 years.

The present study suggests that the distribution of vertical defects within the dentition follows a symmetrical right-hand and left-hand side pattern. Such a symmetry has also been noted by others (5, 6). Moreover, in agreement with earlier studies (4), the frequency of vertical defects was the same in the mandible and the maxilla, whereas it was significantly greater in the posterior as compared to the anterior region of the dentition. There was a tendency toward a greater frequency of vertical defects at mesial sites as compared to distal sites, which is consistent with some earlier studies (6) but not with others (4).

In the present study, no quantitative criteria of defect size or defect depth were applied in the assessment of vertical bone defects. In analogy with previous studies (4, 6, 7) the minimum vertical dimension of the defect was 2 mm. The definition of defect has important bearings on the prevalence and severity. As shown by Persson et al. (5), a shift from 1 mm to 3 mm in the vertical dimension will result in a prevalence reduction from 70% to 30%, i.e. by more than 50%. Similarly, the number of defects of a given size is of importance. It can be seen from the present observations that shifting the number of defects required to be labeled 'affected' from 1 to 5 will cause a reduction in prevalence from 38% to 5%, i.e. by almost 90%.

The present observations suggest that the prevalence of vertical bone loss increases with increasing age. This agrees with recent findings from a longitudinal Swedish population study suggesting a gradual reduction of periodontal bone height with increasing age (11). The authors conclude that a natural, biological, continuous alveolar bone resorption takes place after the age of 30 years. Findings of Papapanou & Wennstrom (10, 12), however, suggest that the presence of angular bone defects is associated with increased risk of further bone loss or even tooth loss. Although the likelihood of exhibiting vertical bone defects increases with age it is not fully known whether the occurrence of single defects signifies the onset of disease. On the other hand, it is highly likely that the occurrence of multiple vertical defects is indicative of a disease process.

In conclusion, the present radiographic study in dentally aware individuals indicates that vertical defects are a comparably rare phenomenon. Although 30%–40% exhibited at least one defect, only a minor proportion exhibited multiple defects. Factors of possible influence on the occurrence and severity of vertical defects will be described in a subsequent paper.

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References

1. Grant DA, Stern IB, Listgarten MA. Periodontics in the tradition of Gottlieb and Orban, 6th ed. St. Louis: Mosby; 1988. p. 363–7.
2. Goaz PW, White SC. Oral radiology: principles and interpretation, 2nd ed. St. Louis: Mosby; 1994. p. 332–3.
3. Carranza Jr FA. Clinical periodontology, 8th ed. Philadelphia: W. B. Saunders; 1996. p. 410–2.
4. Nielsen IM, Glavind L, Karring T. Interproximal periodontal intrabony defects. Prevalence, localization and etiological factors. J Clin Periodontol 1980;7:187–98.
5. Persson RE, Hollender LG, Laurell L, Persson R. Horizontal alveolar bone loss and vertical bone defects in an adult patient population. J Periodontol 1998;69:348–56.
6. Wouters FR, Salonen LE, Hellden LB, Frithiof L. Prevalence of interproximal periodontal intrabony defects in an adult population in Sweden. A radiographic study. J Clin Periodontol 1989; 16:144–9.
7. Papapanou PN, Wennstrom JL, Grondahl K. Periodontal status in relation to age and tooth type. A cross-sectional radiographic study. J Clin Periodontol 1988;15:469–78.
8. Bergstrom J, Eliasson S. Dental care habits, oral hygiene, and gingival health in Swedish professional musicians. Acta Odontol Scand 1985;43:191–7.
9. Bergstrom J, Eliasson S, Dock J. Exposure to tobacco smoking and periodontal health. J Clin Periodontol 2000;27:61–8.
10. Papapanou PN, Wennstrom JL. The angular bony defect as indicator of further alveolar bone loss. J Clin Periodontol 1991; 18:317–22.
11. Hugoson A, Laurell L. A prospective longitudinal study on periodontal bone height changes in a Swedish population. J Clin Periodontol 2000;27:665–74.
12. Papapanou PN, Wennstrom JL, Grondahl K. A 10-year retrospective study of periodontal disease progression. J Clin Periodontol 1989;16:403–11.

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