Assessment of Alveolar Bone Loss and Angular Bony Defects on Panoramic Radiographs

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Abstract

The aim of the present study was to investigate the prevalence and severity of alveolar bone loss and angular bony defects in randomly selected panoramic radiographs. A total of 500 panoramic radiographs of adult patients seeking dental care were studied. The mean age of the subjects was 51 years (range 20-80). The assessments of alveolar bone levels and angular bony defects were performed by direct measurements of the distance between the cemento-enamel junction (CEJ) and bone level. The results demonstrated a gradual and significant increase in the frequency of bone loss with increasing age (p<0.05). Angular bony defects were found in 249 subjects (49.8%) and were most frequent at the mandibular first molar. The mean depth of the angular bony defects was 6.0 mm with the greatest mean depth in the maxillary anterior area (6.8 mm). The mean mesiodistal depth of the intra-bony defects was 2.44 mm, most pronounced in maxillary molars (3.1 mm). In conclusion, the study demonstrated a high prevalence of angular bony defects suitable for regenerative periodontal treatment.

Key words: Panoramic radiographs, angular bony defects, periodontal disease, bone loss

Introduction

The loss of tooth-supporting alveolar bone is one of the characteristic symptoms of destructive periodontal disease. In general, osseous destruction can be according to clinical criteria of horizontal (or even) or angular (or vertical) character. In most instances, angular defects have accompanying infrabony pockets where the base of the defect is located apically to the alveolar crest (Carranza 1984). The occurrence of angular bony defects has been associated with occlusal trauma (Nunn and Harrel 2001), deficient root cementum (Blomlöf et al. 1987) or as a consequence of an asynchronous apical migration of the subgingival plaque along adjacent approximal root surfaces (Lindhe et al. 1975). Moreover, it has been suggested that anatomic factors, for instance the distance between neighboring teeth and the morphology and quality of the alveolar bone may influence the alveolar bone loss pattern (Waerhaug 1979). It has been shown that in absence of systematic periodontal therapy, the presence of an angular bony defect entails an increased risk for further loss of supporting periodontal bone (Papapanou and Wennström 1991). Therefore, the detection and assessment of angular bony defects represents an important factor for the tooth prognosis and the treatment plan aimed at actively eliminating the bony defect. Thus, several therapeutical approaches have been proposed to obtain regeneration of lost periodontal support structures in angular bony defects (Nyman et al. 1982, Pontoriero et al. 1999, Handelsman et al. 1991). It has been demonstrated that for example a benefit from guided tissue regeneration (GTR) for the regenerative treatment of infrabony defects can be expected in defects with at least 4 mm of depth (Laurell et al. 1998). Today, panoramic radiographs supplemented with intra-oral radiographs are used and recommended as the preverable radiographic diagnostic method for the assessment of alveolar bone hight (Åkesson et al. 1989, Molander et al. 1991). An advantage of panoramic radiographs is the reduction in radiation exposure in contrast to intra-oral radiography (Gonzales et al. 2001). However, there are only few studies that have assessed the radiographic appearance of angular bony defects potentially suitable for regenerative periodontal treatment (Rees et al. 1971, Pepelassi et al. 2000). Therefore, the aim of the present study was designed to study the prevalence and severity of angular bony defects on panoramic radiographs of patients seeking regular dental care in an University clinic. A further objective was to evaluate the distribution of furcation lesions as assessed from the panoramic radiographs.

Material and Methods

Panoramic radiographs from 500 patients (237 female and 263 male) aged 20 to 80 years were randomly selected from the Department of Operative Dentistry, University of Mainz, Germany. The panoramic radiographs were placed on a x-ray viewer and evaluated by the same examiner. Radiographic measurements were obtained by using a calibrated periodontal probe (PCPUNC-15, Hu-Friedy, USA) to the nearest mm. Initially, the morphology of the alveolar bone crest on radiographs was divided into “horizontal” or “angular”. A horizontal bone loss was assessed by direct measurement of the distance between the cemento-enamel junction (CEJ) and the most coronal location of the bone margin adjacent to a clearly visible ligament space which was defined as the alveolar bone level (BL). If the interproximal projection of the cemento-enamel junction was not identifiable the apical
termination of a restoration or crown margin was used for the measurements. In the case that a landmark could not be identified, the tooth was excluded from the study. Bone loss was considered to be present when the CEJ to alveolar bone distance was equal to 2.0 mm or more. At sites where angular bony defects were present the depth of the infrabony defect was derived from the distance of the alveolar crest (AC) and the most apical part of the defect. The mesiodistal width of the defect was defined as the distance between the radiographic image of the root surface and that of the osseous border of the defect in the mesiodistal direction at the level of the alveolar crest. A site was considered as having an angular bony defect if the bottom of the oblique radiolucency was located at least 2 mm apical to the most coronal level of the interproximal alveolar bone (Fig. 1). If the examiner could not observe an angular bony defect on the radiograph the alveolar bone level was identical to the alveolar crest. In addition possible furcation involvement of multirooted teeth by assessment of intradicular molar radiolucencies was evaluated.

The statistical data analysis was performed by using SAS (SAS Institute Inc., Cary, NC, USA; Release 9.1). For the descriptive illustration of the results, absolute and percentage frequencies were used for categorical variables and median, mean, minimum and maximum values were used for quantitative and ordinal variables. The correlations between categorical variables were analyzed with contingency tables and Fishers Test (bilateral). The group comparison of quantitative variables was made with the Kruskal-Wallis and the Wilcoxon test for unlinked samples. All statistical tests were used for a descriptive data analysis. P-values ≤0.05 were considered as statistically significant.

RESULTS

Panoramic radiographs from 500 subjects were examined. The mean age of the participants was 51±12.1 years and 48.7 % were women. The frequency distribution of lost teeth was in the younger age group (20-40 years) 12.1 % for the female subjects and 16.4 % for the male subjects (Fig. 2). There was a gradual increase in the frequency distribution of lost teeth with increasing age. Although female subjects exhibited on average a higher frequency of lost teeth in the different age groups no statistically significant difference was observed between female and male subjects (p>0.05). In the majority of subjects (86.7 %) the presence of bone loss (even or angular) could be detected (distance between CEJ to alveolar bone ≥ 2.0 mm). Thus, only a small minority of subjects (13.3 %) exhibited no bone loss. There was a gradual and significant increase in the frequency of bone loss with increasing age (p<0.05). A total of 49.8 % (n = 249) of the 500 subjects demonstrated vertical bony defects. Interestingly, female subjects exhibited a gradual increase of vertical defects with age whereas in male subjects vertical bone loss was most prevalent in the age group 40-60 years and decreased in the older age group (> 60 years, Fig.3). Thus, in the age class 40-60
years 56.1% of osseous defects could be detected in the female subjects versus 59.1% in male subjects. However, in the age class of > 60 years 60% of osseous defects were detected in female subjects as opposed to 40% in male subjects. The classification of the osseous defects in relation to their location demonstrated that angular bony defects were more frequent in the mandible than in the maxilla, most frequent in the mandibular molar area and least frequent in the mandibular anterior area than in any other tooth group (Figs. 4 a, b). Thus, a total of 161 intrabony defects (32.2%) could be detected in the mandibular molar area in comparison to 35 defects (7%) in the mandibular anterior area (Table 1.). In mandibular premolars angular bony defects were less prevalent than in molars but more frequent when compared to incisors. Furthermore, first premolars exhibited less frequent angular bony defects in comparison to second premolars. Most of the angular bony defects had either a small or moderate mesiodistal width. The mean mesiodistal depth of the intrabony defects was 2.44 mm and was most pronounced in maxillary molars (3.1 mm; Table 2). In contrast, mandibular anteriors exhibited a mean mesiodistal width of 1.8 mm. The mean depth of the osseous defects was 6.0 mm with the greatest mean depth of the defects in the maxillary anterior area (6.8 mm; Table 2).

The assessment of furcation lesions by using panoramic radiographs demonstrated that interradicular molar radiolucencies demonstrated 38.3% of the subjects. The interradicular molar radiolucencies were more frequent in the mandible than in the maxilla, most frequent in the mandibular first molar area.

**DISCUSSION**

Panoramic radiographs have been applied successfully in diagnostics and are widely used in general dental practice for assessment of changes in alveolar bone associated with periodontitis. The purpose of the present radiographic investigation was to determine the prevalence, location and dimension of angular bony defects. Therefore, panoramic radiographs of 500 patients were randomly selected from the radiological archive of an University clinic. As the patients were not preselected the radiographic findings from the present study reflect the oral conditions from common patients seeking dental care and not merely patients suffering from periodontal disease. The findings that the subjects showed a gradual and significant decrease of present teeth and bone levels with increasing age are in accordance with several cross-sectional and longitudinal studies on alveolar bone loss (Hugosson et al. 1992, Persson et al. 1998, Papapanou et al. 1989). Several methods have been used for the estimation of alveolar bone levels from radiographs. These methods can be categorised into those where bone loss is assessed by direct measurement from the cemento-enamel junction (CEJ) to the alveolar bone or by measuring the proportion of the tooth length supported by bone (Bjorn and Holmberg 1966, Schei et al. 1959). In the present study bone loss was assessed from panoramic radiographs by direct measurement from

![Fig. 4. a) Classification of the maxillary teeth presenting angular bony defects according to tooth type. b) Classification of the mandibular teeth presenting angular bony defects according to tooth type.](image-url)
the cemento-enamel junction to the alveolar bone. This method used to evaluate bone loss is supported by findings from Kaimenyi and Ashley (1988) indicating that the direct measurement from the CEJ to alveolar bone made on panoramic radiographs is reproducible and possesses validity. Persson et al. (2003) demonstrated for the direct measurements of the CEJ to alveolar bone level consistently better agreements between intra-oral radiographs and panoramic radiographs than the proportional values in relation to root length suggesting that panoramic radiographs should be preferred as the standard radiographic procedure for periodontal radiographic imaging. In a study on dried mandibles investigating the accuracy of measurements made on radiographs (Stoner 1972), the author demonstrated that radiographic and direct CEJ to alveolar bone measurements were equal to or differed by only 1 mm in 87 % of the cases. However, it must be stressed that a limitation of bone level measurements on panoramic radiographs is the varying enlargement of images (Åkesson et al. 1992). On the other hand this might offer an additional benefit to the panoramic radiography as several studies have demonstrated that intra-oral radiographs underestimate the distance between the CEJ and the alveolar bone level (Renvert et al. 1981, Åkesson et al. 1992). Another limitation of bone level measurements on panoramic radiographs is the difficulty in detecting angular bony defects with small buccolingual width or small depth due to the superposition of the buccal over the lingual cortical plate. Such defects where only cancellous bone is involved with only minor changes in bone density can not be imaged radiographically unless the buccal or lingual cortical plate is very thin (Akiyoshi and Mori 1967, Ainamo and Tamisilo 1973). The finding in the present study that the prevalence of angular bone defects generally increased with age is in accordance with results from previous studies (Nielsen et al. 1980, Papapanou et al. 1988). However, the finding that a total of 49.8 % of the subjects presented one or more angular bony defects is at variance with data reported by Persson et al. (1998) and Müller et al. (2005). They reported 30.2 % and 15.8 % of the subjects presenting one or more angular bony defects. The higher age of the patients in our study as well the lower threshold which was set in the present study to 2 mm might explain the higher percentage of patients presenting angular bony defects in the present study. Thus, the threshold was set to 3 mm in the study by Persson et al. (1998) and to 4 mm in the study by Müller et al. (2005) leading to a lower prevalence. On the other hand, our observations are similar with data by Pepelassi et al. (2000) who found angular bony defects most frequent in upper and lower molars and least frequent in the mandibular anterior area. The finding that angular bony defects are more frequently found in upper and lower molars is also in accordance with results of a previous study evaluating the prevalence of intrabony defects in dry human skull material (Larato 1970). In the present study the radiographic evidence of furcation defects suitable for regenerative procedures was found in 38.3 % of all subjects. However, the radiographical analysis of furcation defects is associated with greater errors than the analysis of interproximal bony defects as the severity of furcation involvement can not be identified in the horizontal dimension.

In conclusion, the study indicated that angular bony defects suitable for regenerative periodontal procedures were found in many patients.

**REFERENCES**


Received: March 12, 2007 / Accepted: October 2, 2007

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