Annually and Cumulative Radiographic Alveolar Bone Loss Rates using Digital Scanning Image for the Periodontal Disease Groups before and after Periodontal Treatment

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ABSTRACT

The aim of the present study was to assess the cumulative radiographic alveolar bone loss (CRABL) and yearly radiographic periodontal attachment loss (YRABL) of periodontal disease groups over 5 years or more. A total of 53 subjects, who had taken two sets of full-mouth standardized paralleling radiographs with separated periods of 5 years or more in Kaohsiung Medical University Hospital during 1981-2001, were collected for the past 20 years.

The radiographic alveolar bone levels at mesial and distal aspects of teeth were assessed by measuring the distance between cemento-enamel junction and alveolar bone crest using an electronic digimatic caliper (EDC) under a 3.5X magnified radiographs.

The results revealed that 1) patients with a periodic recall (3-4 times/yr.) showed a significantly lower loss rate than patients without periodic recalls; 2) mean CRPAL was highest in the generalized aggressive periodontitis (GAgP) group (5.52 ± 3.27 mm), then the chronic periodontitis (CP) group (4.82 ± 3.47 mm), and the localized aggressive periodontitis (LAgP) group (4.47 ± 3.47 mm) followed, and lowest in the periodontal healthy (PH) group (1.05 ± 0.59 mm); 3) mean YRPAL was the highest in the LAgP group (0.26 ± 0.25 mm/yr.), then the GAgP group (0.20 ± 0.13 mm/yr.), and the CP group (0.12 ± 0.09 mm/yr.) followed, and lowest in the periodontal healthy group (0.07 ± 0.06 mm/yr.).

It was concluded that: 1) sites with more advanced alveolar bone loss are more likely to undergo further breakdown; 2) patients with a periodic recall showed a significantly lower alveolar bone loss rate and bone gain, irrespective disease groups; 3) mean CPBLs was highest in the GAgP group; mean YRABLs was highest in the LAgP.

Keywords: periodontitis; electronic digimatic caliper; cumulative radiographic periodontal attachment loss (CRPAL); yearly radiographic periodontal attachment loss (YRPAL).

*Period A: Complete formation of tooth root to first radiographic X-ray taking.

*Period B: During First and second radiographic X-ray taking.

*Period C: Complete formation of tooth root to second radiographic X-ray taking.

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I. INTRODUCTION

The cross-sectional and longitudinal studies employing techniques, relating to measuring the rate of clinical attachment lose in individuals with healthy periodontium (HP), chronic periodontitis (CP), and aggressive periodontitis (AgP) [1] with secondary occlusal traumatism (SOT), were documented in the majority of investigators. There is little or no reports regarding studies related to the annually radiographic periodontal bone loss rates among the individuals with periodontal health, chronic periodontitis and aggressive periodontitis with secondary trauma from

occlusion using digital scanning radiographic image analysis [2]-[6].

The reduction in periodontal bone height with increasing age in healthy, and in those chronic periodontitis and aggressive periodontitis, however, wide variations were noted at the different grades of disease stages, and among different types of periodontitis [1], [2], [8], [9].

Report associated with cross-sectional study of digital scanning radiographic image analysis of alveolar bone loss in individuals with untreated adult periodontitis and aggressive periodontitis was presented by Hou, Hung, and Yang et al. [10], [11]

Little or limited data concerning yearly periodontal bone loss rates in the long-term studies among the individuals with, chronic periodontitis, and generalized aggressive periodontitis (GAgP) (Fig. 1), and localized aggressive periodontitis (LAgP) (Fig. 2) at the baseline, treatment

periods, and the end of the study. The purpose of this study was to investigate the differences of cumulative and yearly radiographic alveolar bone loss (YRABL) rates among individuals with healthy periodontium, chronic periodontitis, and aggressive periodontitis, respectively.

Fig. 1. Generalized aggressive periodontitis (GAgP) with radiographic alveolar bone levels (RABLs).

Fig. 2. Localized aggressive periodontitis (LAgP) with radiographic alveolar bone levels (RABLs).

II. MATERIALS AND METHODS

A total of 53 individuals (29 males and 24 females) who reporting or referred to the Periodontal Clinics of Dental School, Kaohsiung Medical University from 1981 to 2001. Those individuals ranging in age from 24 to 66 years (mean age 37.7 ± 11.6 years). The study was conducted to investigate the 53 individuals with 29 AgP (20 GAgP: 9 males & 11 females; 9 LAgP: 6 males & 3 females), 14 chronic periodontitis, CP: 10 males & 4 females), and 10 periodontal healthy: 4 males & 6 females).

Subjects were recalled evaluating the clinical and radiographic for period recall data. The criteria for sample collection comprised the following: 1) individuals have never received periodontal treatment (surgical or nonsurgical); 2) missing teeth were extracted due to periodontal causes; 3) subjects had no chronic systemic diseases. The clinical periodontal examination included age, sex, dental history, plaque index [12], gingival index [13], initial probing pocket depths, clinical attachment levels, teeth, cumulative alveolar bone loss (CABLs) [14], and yearly alveolar bone loss (YABLs) [15]. The flow chart of periodontal treatment in the study was showed in Fig. 3.

Fig. 3. Flow chart of routine non-surgical periodontal Therapy in individuals affected severe advanced periodontitis.

Radiographs showing tooth distortion, poor quality, restoration obliterating the cement enamel junction, producing unreadable measurement points were excluded from the analysis. The proximal CRABL was defined a bony defect in which the distance between CEJ and alveolar crest (AC) was at least 2 mm. Each tooth was measured mesially and distally. The radiographic images of the CEJ(A), AC(B) and root apex (C) were used as three

reference points for the calculation of the radiographic linear measurements of RABL. The distance of AB (RABL) and AC (root length) were measured using digital scanning radiographic image analysis (DSRIA) to determine the percentages (%) and millimeters (mm) of RABLs. Duplicate measurements were obtained for each tooth. All the measurements were numerically coded, and the results were processed and analyzed by the computer system equipped with the MIS [16], [17]. The intra-examiner and inter examiner reliability coefficients demonstrated that the inter and intra-examiner's reliability coefficients in maxillary, mandibular, and of both molars were significantly different from zero ($p < 0.001$) [16], [17].

III. RESULTS

Table I indicated the baseline data of the A period for means of the CRABs among the groups of CP, GAgP, LAgP, and PH were -4.82 ± 3.47 mm, -5.52 ± 3.27 mm, -4.47 ± 3.47 mm, and -1.05 ± 0.59 mm, respectively. The statistical analysis indicated that a significant reduction ($p < 0.0001$) of CRABs. The results present the remarkable differences of the CRABs among the groups affected chronic periodontitis, generalized aggressive and localized aggressive periodontitis, as compared with periodontal healthy group at the A period.

TABLE I: THE DIFFERENCE OF MEAN CRPAL (MM/CR) IN PERIOD A, B AND C BY DIFFERENT PERIODONTAL DISEASE TYPES. (CP: N=14; GAGP: N=20; LAGP: N=9; PH: N=10)

Dis. type	N	n	A period Mean (SD)	B period Mean (SD)	C period Mean (SD)	Significance
CP	14	394	-4.82 (3.47)	-0.30 (1.17)	-3.94 (2.06)	****
GAGP	20	565	-5.52 (3.27)	-0.38 (1.85)	-4.77 (2.73)	****
LAgP	9	269	-4.47 (3.47)	-0.47 (1.52)	-3.53 (2.21)	****
PH	10	457	-1.05 (0.59)			
Significance			****	p=0.3509 (NS)	****	

N: number of tooth sites; n: individual; CP, n=14; GAgP, n=20; LAgP, n=9, PH, n=10) NS: not significant ($p > 0.05$) Significant: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$, **** $p < 0.0001$.

B period indicated the treatment periods and showed that the mean CRABs of CP, GAgP, and LAgP were listed as -0.30 ± 1.17 mm, -0.38 ± 1.85 mm, and -0.47 ± 1.52 mm, respectively.

There is no significance difference ($p = 0.3509$) at the stage B period.

C period showed the mean CRABs of CP, GAgP, and LAgP were listed as -3.94 ± 2.06 mm, -4.77 ± 2.73 mm, and -3.53 ± 2.21 mm, respectively. Results showed a remarkable significant difference of at the end of study of C period ($p < 0.0001$) (Table I).

Results showed that the statistical analysis indicated that a significant reduction ($p < 0.0001$) of CRABs were found at the A period (baseline) and C period (the end of study) among the periodontal disease groups of CP, GAgP, LAgP, and PH. Statistical analysis also showed a strong significance ($p < 0.0001$) among the disease groups, but except the groups of CP, GAgP, and LAgP at the B period with no significance $p=0.3509$.

Table II showed the baseline data of the A period in the means of the YRABs (mm/yr) among the groups of CP, GAgP, LAgP, and PH were -0.12 ± 0.09 mm,

-0.22 ± 0.16 mm, -0.23 ± 0.24 mm, and -0.07 ± 0.06 mm, respectively. B period demonstrated that the means of YRABs among the groups of CP, GAgP, and LAgP were -0.04 ± 0.18 mm, 0.08 ± 0.29 mm, and 0.05 ± 0.21 mm after periodontal treatment. C period illustrated that the means of YRABs among the groups of CP, GAgP, and LAgP were -0.09 ± 0.05 mm, -0.14 ± 0.09 mm, and -0.12 ± 0.08 mm.

TABLE II: THE DIFFERENCE OF MEAN YRABs (MM/YR.) IN PERIOD A, B AND C BY DIFFERENT PERIODONTAL DISEASE TYPES (CP: N=14; GAGP: N=20; LAGP: N=9; PH: N=10)

Dis. type	N	N	A period Mean (SD)	B period Mean (SD)	C period Mean (SD)	Significance
CP	14	394	-0.12 (0.09)	-0.04 (0.18)	-0.09 (0.05)	****
GAGP	20	565	-0.22 (0.16)	-0.08 (0.29)	-0.14 (0.09)	****
LAgP	9	269	-0.23 (0.24)	-0.05 (0.21)	-0.12 (0.08)	****
PH	10	457	-0.07 (0.06)			
Significance			****	p=0.3509 (NS)	****	

N: number of sites; n: individual; CP, n=14; GAgP, n=20; LAgP, n=9.

NS: not significant ($p > 0.05$).

Significant: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$, **** $p < 0.0001$.

Results showed that the statistical analysis indicated that a significant reduction ($p < 0.0001$) of YRABs were found at the A period (baseline) and C period (the end of study) among the periodontal disease groups of CP, GAgP, LAgP, and PH. Statistical analysis also showed a strong significance ($p < 0.0001$) among the disease groups of A period and C periods, except the groups of CP, GAgP, and LAgP at the B period with no significance ($p = 0.3509$).

Results of this study also presented that the periodic recall visits of periodontal maintain therapy showed remarkable periodontal attachment gain, irrespective of different disease types. The disease groups showed there is no difference of YRABs (mm/yr.) during the treatment periods (B periods).

IV. DISCUSSION

The present study demonstrated that the DSRIA resulted in a high value of correlation coefficients in the intra-examiner's ($r=0.995$ and 0.996 , $p < 0.001$, respectively) and inter-examiner's ($r=0.995$ and 0.994 , $p < 0.001$) reliability test to measure the periodontal bone loss [8]. Therefore, by employing the DSRIA to assess the proximal alveolar bone loss in the present study seems to be able to get more accurate values of RABL as compared to those used by traditional methods that were reported earlier [17].

Little or limited literatures reported the information regarding the cross-sectional and longitudinal studies employing non-surgical periodontal treatment techniques combined with the Sandwich's technique [18]. In addition, methods relating to the rates of periodontal and radiographic alveolar loss in individuals with health periodontium, chronic periodontitis and aggressive periodontitis have limited been documented using mainly clinical probing and radiographic measurements [19].

The present study longitudinally investigated concerning yearly alveolar bone loss (YRABs) and cumulative alveolar bone loss (CRABs) in the long-term study among the individuals with chronic periodontitis, and aggressive periodontitis, and the periodontal health groups at the baseline (Period A), treatment periods (Period B), and the end of the study (Period C). The present report indicated that

the differences of mean CRABs (mm/cr) at the baseline, GAgP was the most cumulative periodontal bone loss (-5.52 ± 3.27 mm), second was the CP (-4.82 ± 3.47), third was the LAgP (-4.4 ± 3.47 mm) by different periodontal disease types, as compared to the PH group (-1.05 ± 0.59 mm) (Table I). There existed a strong significance using the statistical analysis ($p < 0.0001$) and it means that these disease groups affected different remarkable periodontal bone loss of both CRABs (mm/cr), respectively, at the period A (baseline data). In addition, results also showed that the mean YRABs (mm/yr) in the LAgP was the highest (-0.23 mm/yr), secondly GAgP (-0.22 mm/yr), followed by CP (-0.12 mm/yr), PH (-0.07 mm/yr) was the least at the Period A (Table II).

The period B demonstrates the means of CRABs and YRABs (% & mm) during the treatment periods between first radiographic X-ray taking and second taking, respectively. The period C illustrates the means of CRABs and YRABs (% & mm) from the complete tooth maturation to the end of study. As far as literatures report [7], it seems to be a relative quite rare.

The individuals of the present study were regularly treated with a series of four phase's periodontal therapies except phase 3 (flap operation), routinely, including oral hygiene instruction, scaling/root planning, and pocket irrigation with 0.1% chlorhexidine gluconate solution (Scodyl-F, cGMP, Washington Pharmaceutical Co., Taiwan) after informed consent was given.

Provisional fixed crowns were recommended as a treatment approach of a therapeutic periodontal prosthesis (TPP) in the treatment of severely advanced periodontitis with guarded prognosis. [20], [21] In addition, the periodontal and prosthetic designs of CSC telescopic denture is a removable prosthesis provided not only advantages, such as stabilization of hypermobile abutments, easy control of microbial dental plaque, but also decrease torque force of teeth, reduce leveling force on the weak abutments affected SAP with SOT [20]-[22].

Although, it has well been known that parallel radiographic method is not an accurate measurement for interproximal RABL, but reliability, validity and relatively specificity had been shown to be of essential importance. Especially, the combined use of the standardized paralleling radiographic technique with Eggen film holders to assess the clinical measurements of the alveolar bone levels was useful in either cross-sectional epidemiological or longitudinal follow-up survey [23]-[25]. Still there are some other advantages mentioned by Salomen et al. [26] that it is possible to control the reproducibility of the diagnostic interpretation over time for the longitudinal follow-up survey. The variation in the beam projection that resulted in the foreshortening or elongation of radiographic image can be effectively minimized by using % of the ratio of interproximal RABL to the root length or tooth length measured from the periapical radiograph [24], [27]-[28].

REFERENCES

- [1] Armitage GC. Development of a classification system for periodontal diseases and conditions. *Ann Periodontol* 1999; 4(1): 1-6.
- [2] Boyle WD, Via WF, McFacc WT. Radiographic analysis of alveolar crest height and age. *J Periodontol* 1973; 44(4): 236-242.
- [3] Straham JD. Relation of the mucogingival junction to alveolar bone margin. *Academy Rev* 1965; 13(1): 23-28.
- [4] Oconner TW, Biggs NL. *J Periodontol* 1965; 35(4):326-330.
- [5] Selikowitz HS, Sheiham A, Albert D, Williams GM. Retrospective longitudinal study of the rate of alveolar bone loss in humans using bitewing radiographs. *J Clin Periodontol* 1981; 8(5): 431-438.
- [6] Suomi JD, Plumo J, Barbano JP. A comparative study of radiographs and pocket measurements in periodontal disease evaluation. *J Periodontol* 1968; 39(6): 311-315.
- [7] Hou GL. Annually radiographic periodontal bone loss rates of tooth affected severe advanced periodontitis with secondary occlusal traumatism. *Intern J Dent and Oral Health* 2020; volume 6 issue 6: 1-6.
- [8] Manson JD, Nicholson K. The distribution of bone defect in chronic periodontitis. *J Periodontol* 1974; 45(2): 88-92.
- [9] Albander JM, Brown LJ, Genco RJ, Loe JH. *J Periodontol* 1997; 68(6): 545-555.
- [10] Hou GL, Hung CC, Yang YH, et al. Periodontal bone loss in Chinese subjects with untreated early-onset and adult periodontitis: A cross-sectional study using digital scanning radiographic image analysis. *Kaohsiung J Med Sci* 2002; 18: 500-507.
- [11] Hou GL, Hung CC, Yang YS, Shieh TY, and Tsai CC. Radiographic alveolar bone loss in untreated Taiwan Chinese subjects with adult periodontitis measured by the digital scanning radiographic image analysis methods. *Dentomaxillofacial Radiology* 2003; 32: 104-108.
- [12] Silness J, Loe H. Periodontal disease in pregnancy: II. Correlation between oral hygiene and periodontal condition. *Acta Odont Scand* 1964; 22: 121-135.
- [13] Loe H, Silness J. Periodontal disease in pregnancy: I. Prevalence and severity. *Acta Odontol Scand* 1963; 21: 533-551.
- [14] Hou GL. Digital scanning radiographic image analysis of alveolar bone loss in individuals with untreated adult periodontitis and aggressive periodontitis: A cross-sectional study. *Advances in Dentistry & Oral Health* 2020; 13(4): 68-75.
- [15] Hou GL. Annually radiographic periodontal bone loss rates of tooth affected severe advanced periodontitis with secondary occlusal traumatism. *Intern J Dent and Oral Health* 2020; volume 6, Issue 6: 1-5.
- [16] Hou GL, Lin CH, Hung CC, Yang YS, et al. The consistency and reliability of periodontal bone level measurements using digital radiographic image analysis – A pilot study. *Kaohsiung J Med Sci* 2000;16: 566-573.
- [17] Hou GL. Digital scanning radiographic image analysis of alveolar bone loss in individuals with untreated adult periodontitis and aggressive periodontitis: A cross-section- al study. *Advances in Dent & Oral Health* 2020; 13(4): 68-74.
- [18] Hou GL, Hou LT. Therapeutic outcomes using the Sandwich's technique in treating severe advanced periodontitis with secondary occlusal traumatism. A long-term study for 5.1-39 years. *Intern J Dent and Oral Health* 2019; October: Volume 5, Issue 7:64-73.
- [19] Armitage GC. Development of a classification system for periodontal diseases and conditions. *Ann Periodontol* 1999; 4(1): 1-6.
- [20] Hou GL, Tsai CC, Weisgold AS. Treatment of molar furcation involvement using root separation and a crown and sleeve-coping telescopic denture. A longitudinal study. *J Periodontol* 1999; 70(9): 1098-1109.
- [21] Hou GL. Survival rates of CSC telescopic abutments of severe advanced periodontitis with secondary occlusal traumatism using periodontal and prosthetic therapies. A long-term study of case series for 5.1-19.3 years. *Advances in Dentistry & Oral Health* 2020; 13(1): 250-257.
- [22] Hou GL, Tsai CC, Weisgold AS. Periodontal and prosthetic therapy in severely advanced periodontitis by the use of the crown sleeve-coping telescopic denture. A longitudinal case report. *Australian Dent J* 1997; 42(3): 169-174.
- [23] Wouters FR, Lavstedt S, Frithiof L, et al. A computerized system to measure interproximal alveolar bone levels in epidemiological radiographic investigations. II. Intra- and inter-examiner variation study. *Acta Odont Scand* 1988;48(1): 33-39.
- [24] Wouters FR, Jon-And C, Frithiof L., et al. A computerized system to measure interproximal alveolar bone levels in epidemiological radiographic investigations. I. Methodological study. *Acta Odont Scand* 1988; 46(1): 25-31.
- [25] Eggen S. Standardized projection technique in intra-oral roentgenography. *Sven Tandlakar Tidn* 1969; 61: 768-872.
- [26] Salonen LWE, Frithiof L, Wouters FR., et al. Marginal alveolar bone height in an adult Swedish population: A radiographic cross-sectional epidemiological study. *J Clin Periodontol* 1984; 18(4): 223-232.

- [27] Rise J, Albandar JM. Pattern of alveolar bone loss and reliability of measurements of the radiographic technique. *Acta Odont Scand* 1988; 46(4): 227-232.
- [28] Nielsen IM, Glavind L, Karring T. Interproximal periodontal intra-bony defects. Prevalence, location, and etiological factors. *J Clin Periodontol* 1980; 7(3): 187-198.