Digital radiographic evaluation of alveolar bone loss, density and lamina dura integrity on post splinting mandibular anterior with chronic periodontitis

Digital radiographic evaluation of alveolar bone loss, density and lamina dura integrity on post splinting mandibular anterior with chronic periodontitis

F Rafini[1], M Priaminiarti[2], I Sukardi[1] and R Lessang[1*]

[1] Department of Periodontics, Faculty of Dentistry, Universitas Indonesia, Jakarta, Indonesia
[2] Department of Oral and Maxillofacial Radiology, Faculty of Dentistry, Universitas Indonesia, Jakarta, Indonesia

*E-mail: robertlessang@gmail.com

Abstract. The healing of periodontal splinting can be detected both with clinical and radiographic examination. In this study, the alveolar bone was evaluated by radiographic digital periapical analysis. Periodontal tooth splinting is periodontal support therapy used to prevent periodontal injury during repair and regeneration of periodontal therapy. Radiographic digital periapical analysis of alveolar bone in the mandibular anterior region with chronic periodontitis and 2/3 cervical bone loss after three months of periodontal splinting. Eighty four proximal site (43 mesial and 41 distal) from 16 patients with chronic periodontitis and treated with spinting were examined by taking periapical digital radiographic at day 1 and 91. The bone loss, bone density and utility of lamina dura were evaluated. The statistical analysis after three months evaluation using T-test for bone loss, Wilcoxon sign rank test for bone density and utility lamina dura showed no significantly differences (p<0.05) (p=0.44, 0.256 and 0.059). No radiographic change in bone loss, bone density and utility of lamina dura from chronic periodontitis with 2/3 alveolar bone loss after three months splinting.

1. Introduction

Chronic periodontitis is commonly found in adults from 35 years of age, due to bacterial infection of plaque and may cause attachment loss in periodontal tissue. Its inflammation is slow and increasing by aging. If it gets worse, it can cause alveolar bone loss and tooth mobility [1-3]. Mandibular anterior teeth is compromised because in this region, excessive tooth mobility often occurs because of posterior tooth loss, traumatic occlusion or dental malposition so patient will feel difficult in doing masticatory function properly. Most of tooth mobility in these region due to quantitative factor i.e. the loss of supporting tissue and qualitative factor i.e. the supporting tissue structure change that been previously damaged because of secondary traumatic occlusion [4]. Tooth mobility preventive therapy to avoid becoming worse is splinting [5-9]. Role and benefit of splinting for periodontal therapy is still controversial and questionable [5,10,12]. Splinting cannot make teeth become fixed back, but only as a unsteadiness control, stabilization of occlusion and increased patient comfort [5,6,9,13].

Perlitsh stated that the term critical mass of alveolar bone support is as the quality and quantity of alveolar bone that supports the alveolar bone crest area on 1/3 to 1/3 apical to make adaptive changes in the form of bone regeneration and healing. The ability of periodontal ligament regeneration and repair on supporting tissues occurs when there is a minimum of 50% of roots length that is still supported by alveolar bone or bone loss is minimally up to 2/3 the length of roots [13]. Periodontal

abnormalities with splinting indications require periapical radiographic examination for evaluation of alveolar bone changes before and after therapy. Based on the 1999 AAP classification, periodontal abnormalities with clinical attachment loss >3-6 mm are moderate to severe chronic periodontitis. Based on the ADA classification, radiographically, the category is if the alveolar bone loss up to 30-60% of the CEJ or loss of bone support up to 2/3 of the cervix (rest of alveolar bone support with maximally 1/3 root apical) [1,14,15].

From previous studies it was noted that cancellous and cortical bone remineralization will reach 99% within one year, namely lamellar bone formation. At this stage of the formation of woven bone, alveolar bone mineralization is only 30% and reached within three months [16,17]. According to study of post-extraction by Schropp et al (2003) [16], the highest rate of alveolar bone formation was the first three months, as well as study of Ejlali (1995), which concluded that alveolar bone healing after extraction was 2-3 months [17]. Period of three months of this healing process was in line with the laboratory study of microscopic evaluation about subgingival microflora with conclusion that three months interval visit during maintenance phase was considered effective in preventing recurrence of periodontitis [9]. Based on this, the evaluation of alveolar bone after periodontal splinting in this study was that after three months (day 91). Based on the background of the problem, formulated study problem i.e. is there alveolar alveolar bone loss and integrity of lamina dura on the mandibular anterior teeth with chronic periodontitis and bone loss criteria up to 2/3 cervix after three months splinting? The expected benefits of this study is that the result of study may be useful for evidence-based approach Periodontology application. For dentists, it could be as a treatment reference on splinting indications and for the study subjects with chronic periodontitis is to know the benefits of periodontal splinting so they will immediately consult the dentist / periodontist if suffering tooth mobility with splinting indication.

2. Materials and Methods

This study was a clinical experimental study of a single treatment before and after three months of splinting. The study population was chronic periodontitis patients aged 35-59 years and had two or three degrees of tooth mobility on their mandibular anterior teeth. The study sample was the proximal side of the mandibular anterior teeth (32-31-41-42) with loss of alveolar bone up to 2/3 of the cervix. Study inclusion criteria was men or women aged 35-59 years with a diagnosis of chronic periodontitis and tooth mobility about 2-3 on teeth of 32-31-41-42 and willing to fill out an informed consent. Exclusion criteria of this study was 32-31-41-42 teeth by trauma occlusion (posterior missing tooth that not replaced, parafunctional, malocclusion (edge to edge, deep bite, cross bite), shape and cross-sectional area of abnormal tooth root, not proportional of root-crown ratio), having or after endodontic treatment, pulpitis, non-vital, periodontal and periapical abscess, having periodontal surgical intervention last 12 months, crowding that cannot interpreted by radiographic because of overlapping, having diabetes mellitus condition, or smoking habit. In this study the independent variables was splinting, the dependent variable were bone density loss and lamina dura integrity, the confounding variable was trauma occlusion.

Instruments and materials of study were ø 0.25 mm of wire ligature and composites, bite registration material (3M), basic dental instrument (dental mirror no. 4 (Osung, Korea), tweezers (Crown, Japan), halfmoon instrument (Crown, Japan), periodontal probe with mm scale (ASA, Italy), ultrasonic scaller (EMS, Germany), radiography long cone beam engine (Belmont), Paralelling Cone Indicator Device (PCID) (Hanshin CID-3), Computer LG, Digora for Window, photostimulable PSP sensor. In this study, if there was trauma occlusion due to obstacles or occlusion, it was checked before the study was started then occlusion was first adjusted. Patients with chronic periodontitis with inclusion criteria and willing to participate, were subjected to the study. Clinical procedures of scaling, root refining and irrigation with 3% H2O2 and povidone iodine were performed at 1st, 31st, 61st and 91st of day. Clinical data that recorded were pocket depth, clinical attachment, oral hygiene index and bleeding rate. Teeth wobbles are examined based on the Miller index at 1st day (before the splint was

attached) and 91st day (after the splint was relaxed). On the 31st and 61st day, splinting condition was examined. If splinting was loose, down, break or it irritated gingiva, it needed to be corrected again. On the 91st day, on dental follow up, the splints were loosened first, then reassembled. Oral hygiene instructions was given for patients, especially about procedure of cleaning plaque and debris on splinting teeth.

Digital computerized radiography system at the dental teaching hospital, Faculty of Dentistry, Universitas Indonesia used was Digora for Windows System. The step of radiographic work was on the 1st and 91st day, before and after splint attached, patient inclusion criteria were done in digital radiography with parallel and assistance periapical PCID as well as bite registration. The intended use was done in order to get a bite registration radiographic appearance and the same angle before-after three months of splinting. Examination of alveolar bone loss and lamina dura integrity were performed per tooth (mesial and distally separated) on the monitor. The radiographic analysis of all dependent variables was observed directly from the monitor with the Microsoft Digora for Windows program and magnification 1-1.5 times and detected through Magni Viewer III, Progen Tokyo. Unidentified surface because of CEJ overlapping in radiographic was excluded [18]. In this study used a measurement technique based on the method of bone loss used in previous study to draw the line from CEJ to the top of the bone [19]. Alveolar bone density value was recorded based on the results seen Grayscale pixels on a computer monitor on ROI. The integrity of lamina dura [20,21] was observed ordinalnya scale based on Greenstein criteria [22]. Examination of alveolar bone loss was done by two inter-examiners. Each examiner performed two readings (intra-examiner). Determination results of measuring bone loss before and after three months of splinting based TEM (Technical Error Measurement) procedures [23]. Bivariate analysis was used to analyze changes that occurred in the dependent variable: alveolar bone loss, alveolar bone density and lamina dura integrity before and after three months of splinting. SPSS V.20 was used for data processing with $p<0.05$ as significance limits.

3. Results

The number of study samples were 84 sided teeth derived from 46 mandibular anterior incisors with 16 subjects. Age range was <35 years old 0 people, 36-55 years as many as 13 people and> 55 years 3 people. All of the samples were chronic periodontitis patients. Education subject of the study were 3 people of high school grade, 3 people of diploma grade, 9 people of undergraduate grade and one person with unknown education. Calculation of data normality test in this research used Kolmogorov Smirnov test because categorized big sample (> 50 side of sample) that were 44 side mesial and 40 side distal. The significance value of alveolar bone loss was 0.2 so that bone loss was normal data distribution ($p>0.05$). The significance value of alveolar bone density was 0.023 so that the data distribution was not normal ($p<0.05$).

This study that used the data changes in alveolar bone loss with the lowest TEM value of 0.14626 mm to its initial state before the tooth splinting and 0.171028 mm for dental situation after three months in splinting, and each was taken their mean. Value of bone loss after 3 months in splinting is the difference between the values of TEM end of the initial reduced. Based on result of Wilcoxon test, change in alveolar bone loss and bone density is not statistically significant before and after three months of splinting in chronic periodontitis. 2/3 cervical bone loss criteria ($p>0.05$). (Table 1)

Table 1. Differences Before and After Splinting in Chronic Periodontitis 2/3 Cervical Bone Criteria

Measurement	Before		After		*p*-value
	Means (SD)	Min – Max	Means (SD)	Min – Max	
Bone loss	7.08 (8.7) mm	3.59 – 1.64 mm	7.02 (7.8) mm	2.45 – 11.46 mm	0.44
Bone density	49.3 (8.7) Grayscale	34.44 – 70.04 Grayscale	47.6 (7.8) Grayscale	33.83 – 75.97 Grayscale	0.256

The number of sides of the tooth with reduction of bone loss was 51.2% (43 persons), while the number of teeth with the addition of bone loss was 48.8% (41 people). Number of side teeth with bone density increased to 57.1% (48 sides) while the number of teeth with reduction of bone loss was 42.9% (36 sides). (Table 2)

Table 2. Change in Bone Loss and Bone Density After Splinting

Measurement	Change	N (%)	Means	Median	Min – Max
Bone loss	Reduction	43 (51.52)	0.53 mm	-0.33 mm	-2.29 – (-0.05) mm
	Addition	41 (48.8)	0.43 mm	0.29 mm	0.00 – 3.11 mm
Bone density	Reduction	36 (42.9)	-8.12 Grayscale	-8.63 Grayscale	-24.37 – (-0.04) Grayscale
	Addition	48 (57.1)	3.14 Grayscale	2.54 Grayscale	0.00 – 8.69 Grayscale

Based on result of Wilcoxon test, there is no statistically significant change of lamina dura integrity before and after three months of splinting in chronic periodontitis, and the criteria of alveolar bone loss to 2/3 cervix (p= 0.059). Of the 84 sides of sample, before splinting there were 15 sides with the lamina dura lost status, 43 sides with discontinued dura lamina status and 26 sides with intact lamina dura status. After splinting, one side of the sample had changed from being disconnected became lost and six sides of the sample had changed from disconnected became intact. (Table 3)

Table 3. Change in Lamina Dura State After Splinting

		State After Splinting, N (%)			Total
		Lost	Discontinued	Intact	
State Before Splinting N, (%)	**Lost**	15 (93.8)	0 (0)	0 (0)	15 (17.9)
	Discontinued	1 (6.3)	36 (100)	6 (18.8)	43 (51.2)
	Intact	0 (0)	0 (0)	26 (81.3)	26 (31)
Total		16 (19.04)	36 (42.86)	32 (38.1)	84 (100)

4. Discussion

The absence of changes in bone density loss and significant due to the limited time of the study, whereas in a similar study on the improvement of bone density, it is stated that a whole new alveolar bone began filling trabecular bone after 64 days [24]. In terms of the quantity of bone healing, Eugene Robert stated crest woven formation of new bone after three months, while mature new bone formation begins 6-8 months after treatment [25]. Other factors that cause alveolar loss and density change are not significant because in this study, it was only done to the extent of initial therapy so that surgical intervention had not been done to achieve maximum tissue regeneration. In the initial periodontal therapy, the healing process of tissue repair as the repair process is characterized by the formation of epithelial tissue or connective tissue and then form *new attachments* (new attachment) [26,27]. The age span of the subjects in this study should be narrowed to obtain a meaningful evaluation of changes in bone loss and density. Some experts argue that elderly age and age are a risk factor for periodontitis because physiologically, there is a change in periodontal tissue where bone density and bone healing have a response to periodontal therapy to decrease. The risk factors in elderly specifics are hard to determine, but theoretically the change to the *aging process* started at the age of 65 years [27,28].

The result of alveolar change in alveolar loss and density in this study was not significant either due to the low sample size of 84 samples from 16 patients, while 4 study subjects were forced to exclude due to absence after three months for radiographic splinting evaluation. The average yield of

alveolar bone density before and after three months of splinting decreased from 49.3 Grayscale to 47.6 Grayscale, but clinically the mean of reduction value of tooth mobility actually decreased from 2.35 to 1.87, while the number of sample sides with increased alveolar bone density was greater than the number of sample sides with decreased alveolar bone density i.e. 48 sides (57.1%) and 36 sides (42.9%). One of the causes of a decrease in the mean value of alveolar bone density before and after three months of splinting may be caused by women who had not detected prior bone quality status as the most subject in this study. Rajinder et al in his study presented tooth mobility relationship with alveolar bone density in 119 women with mean age of 48 years, grouping samples into groups with BMD *(bone mineral density)* was low (osteoporosis, osteopenia) and normal. From his study results showed there was a correlation between tooth agitation with low BMD group (osteoporosis and osteopenia) but no correlation in the control group (non-systemic BMD) [29].

The mean yield of alveolar bone loss before and after three months of splinting were 7.08 mm and 7.02 mm, thus corresponding to the mean grade reduction of 2.345 mm to 1.87 mm, while the number of side sample with reduced alveolar bone loss was greater than the number of sided samples with increased alveolar bone loss of 43 sides (51.2%) and 41 sides (48.8%). Reduction of bone quantity may be caused by very strong use of splinting force, very thick diameter of the ligature splint and wrong choice of splinting techniques, that all these factors may inhibit the bone healing process, otherwise the ligature was too loose so it was decreased and not immediately corrected that effect on bone healing process. The splint diameter used in this study was 0.25 mm. According to Yildirim et al, selection and stabilization techniques mechanical splints adequate impact on our health and healing of bone in order to maximize the age of remaining teeth [30], while the placement of ligature splints that one can cause lesions so that inflammation of the gingival persists, loss of attachment remains and alveolar bones will not be restored [31].

The slight change in lamina dura integrity status may be due to poor evaluation time because based on the results of study conducted by Rams et al. It turns out the lamina dura wholeness change as a parameter to predict new periodontitis after 24 months. It shows stable periodontal status after routine quarterly evaluation every three months for 36 months [22]. All patients in this study reduced their Oral Hygiene Index (OHIS) before and after three months of splinting, but on 19 samples from three patients, OHIS from the third month was around 1-1.2, while the other 65 samples had their OHIS less than 1 after three months in splinting. Effective plaque control becomes one of the most successful determinants of overall periodontal therapy. Studies have shown that poor plaque control is one of the failure causes of periodontal therapy, as it may interfere with the formation of adhesions and new bone tissue. Nyman and Lang in their review article of Mahijeet adaptations et al expressed that in patients with more than 50% of attachment loss which it is as very good oral hygiene standards, will provide the results of a long and maximum stability of the teeth in the splint [32].

The results showed that the mean value of increment and reduction of alveolar bone loss were 0.43 mm and 0.53 mm, only slightly different or both ratio were similar. The alveolar bone damage that occurring in this study was averaged due to a combination of plaque-calculus with secondary occlusion trauma. This study results contradict the results of a similar study by Jin and Cao about the reliability of various clinical signs and radiographic trauma occlusion on the severity of periodontitis, which, according to his study, there was a significant difference in alveolar bone loss in teeth with or without normal occlusal contact (premature contact, posterior tooth obstruction during lateral movement, protrusive movement and premature contact on anterior teeth) ($p > 0.05$) [33]. *American Academy of Periodontology* (AAP) states that tooth mobility caused by trauma occlusion if not getting proper treatment in patients with chronic periodontitis will cause progressive bone destruction and even the tooth prognosis was questionable because of the risk of *tooth loss* so that teeth need to be fitted over a splint [15]. According Preethe et al, occlusal consideration should be taken before splinting. The most important thing to note is to perform an occlusal evaluation of patients with periodontitis that their bone support has been lost. Controlling over the direction, magnitude, distribution and intensity of functional and parafunctional force should be performed periodically. The

occlusal treatment plan should be principled to the occlusal forces that are later transmitted to the greatest residual alveolar bone support [34].

5. Conclusion

In this study it was concluded that there was no significant change in alveolar bone loss and density as well as lamina dura integrity of mandibular anterior teeth with a diagnosis of chronic periodontitis which its alveolar bone loss was up to 2/3 of cervix after three months splinting. Suggestion from the results of this study was as a study to evaluate minimal alveolar bone healing in similar one, especially regarding splinting for four months. In the study of splinting, mean of subject age should be minimized and grouped according to gender. To clarify further splinting effect, the treatment may be divided into splinting groups by scaling and root refinement as well as splinting groups with flap or curettage. It is necessary to report the results of study on the community about the importance of maintaining the health of periodontal tissue in general and splinting therapy as supportive therapy for prevent and aggravate periodontitis.

References

[1] Novak J 2006 Classification of Disease and Condition Affecting The Periodontium. In: Newman, Takei, Klokkevold, Carranza, eds. *Carranza's Clinical Periodontology*. 10th ed. (St Louis, Missouri: Saunders, Elsevier) p 100-109.
[2] Novak J and Novak K 2006 Chronic Periodontitis. In: Newman, Takei, Klokkevold, Carranza., eds. *Carranza' Clinical Periodontology*. 10th ed. (St Louis, Missouri: Saunders, Elsevier). p 494-99.
[3] Jayachandran P 1999 Tooth Mobility. Advanced Dynamic Products for Discerning Dental Surgeons. *J. Soc. Periodont. Implantol. Kerala*. **3**.
[4] Palmer RM, Ide M, Floyd PD 2014 Clinical Guide to Periodontology:part 3. Multidisciplinary integrtated treatment *British Dental Journal* **216** 567-573.
[5] Rapelli G 2002 Tooth splinting with fiber-reinforced composite materials: achieving predictable aesthetics *Pract Proced Aesthec Dent* **14** 495-500
[6] Lambert DL 2015 Splinting rationale and contemporary treatment options for luxated and avulsed permanent teeth *Gen Dent* **63** 56-60.
[7] Kahler B, Hu JY, Marriot-Smith CS, Heithersay GS, Marriot-Smith CS, Heithersay GS 2016 Splinting of teeth following trauma: a review and a new splinting recommendation *Aust Dent J* **61** 59-73.
[8] Gher 2000 Peranan Oklusi terhadap Kondisi Jaringan Periodontal yang Sehat dan Berpenyakit. *Silabus Periodonti.* EGC, PBK. p 661-695.
[9] Merrin 2006 Supportive Periodontal Treatment. In: Newman, Takei, Klokkevold, Carranza., eds. *Carranza's Clinical Periodontology*. 10th ed. (St Louis, Missouri: Saunders, Elsevier) p. 1194.
[10] Howard, Strassler and Brown C 2001 Periodontal Splinting with A Thin High Modulus Polyethylene Ribbon. *Compendium*. August 2001; **22** 610-18
[11] Yuan L J 2006 Periodontal Splinting. *J. Ontario. Dent.* 24-7.
[12] Griffin and Cole 2005 Splint or Not to Splint: Treating Periodontally Compromised Teeth by Improving Occlusion. Continuing Education. *J. Contemp. Esthet. Restor. Pract.* **2005** 2-10.
[13] Sato K., Muramatsu T, Tsuchiya Y, Masaoka T, Enokiya Y, Hashimoto S, Shimono M 2010 Proliferation, migration and apoptosis of periodontal ligament cells after tooth replantation *Oral Diseases* **16** 263–268.
[14] Harring and Jansen 2006 *Interpretation of Periodontal Disease*. 2th ed. p 384-436.
[15] Whaites and Cawson 2007 The Periodontal Tissue and Periodontal Disease. *Essentials of Dental Radiography and Radiology*. 4th ed. (United Kingdom: Churchill Livingstone, Elsevier) p 277-88.

[16] Schropp L, Wenzel A and Kostopoulos L 2003 Bone Healing and Soft Tissue Contour Changes Following Single Tooth Extraction: A Clinical and Radiography 12 Month Perspective Study. *J. Periodont. Restor. Dent.* **23** 313-32.
[17] Haghighat A, Abdinian M and Sadeghkhani. Radiographic evaluation of bone formation and density changes after mandibular third molar extraction: a six months follow up. *J. Dent. Restor.* **8** 1-5.
[18] Pecoraro, Janal and Knocht 2005 Comparison of observer reliability in assessing alveolar bone height on direct digital and conventional radiographs. *J. Dentomaxillofac. RadioL*. **34** 279-84.
[19] Albandar 1986 A radiographic quantification of alveolar bone level changes. Comparison of three currently used methods. *J Clinical of Periodontology*. **13** 810-13.
[20] Iskandar H B 2004 Evaluasi Radiometrik Kepadatan Trabekulasi Mandibula Normal Dengan DDIR (Perbandingan dengan Foto Dental Konvensional). *J. Indones. Dent. Assoc.* **7**.
[21] Nobrega and Puchnick 2012 In vitro study on radiographic graylevels of biomaterial using two digital image methods. *J. Odonto. Sci.* **27** 218-22.
[22] White SC, Pharoah MJ 2014 *Oral Radiology: principle and interpretation 7th Ed*. (Canada: Elsevier).
[23] Norton, Jones and Wittingham *et al*. Technical Error of Measurement. Anthropometric Assesssment Protocol.
[24] Ellis, Hupp and Tucke M R 2002 *Contemporary Oral and Maxillofacial Surgey*. (4th ed). (Philadelphia: Mosby).
[25] Robert 2008 Bone Physiology, Metabolism, Biomechanics In: CE M, editor. *Contemporary Implant Dentistry*. (St Louis: Mosby). p 557-98.
[26] Rose 2004 Periodontal Regeneration and Reconstruction Surgery. In Rose, Mealey and Genco *et al*. *Periodontics, Medicine, Surgery and Implants*. (St Louis, Missouri: Elsevier, Mosby). p 573-609.
[27] Kornman and Robertson 2000 Fundamental principles affecting the outcome of theraphy for osseus lesions. *Periodontology* **22** 22-43.
[28] Rees T 2005 Faktor Penyerta Sistemik: *Lippincott, Williams and Wilkins*
[29] Rajinder S *et al* 2012 Correlation of tooth mobility with systemic bone mineral density and periodontal status in indian women. *J of Oral Science* **54** 177-82.
[30] Yildirim, Autoglu and Karaman 2006 An alternative method for splinting of trumatized teeth. *J. Dent. Traumatol.* **22** 345-49.
[31] Watkins SJ, Hemmings KW 2000 Splinting in General Dental Practice *Dent Update* **27** 278-285.
[32] Puri, Grover, Gupta *et al* 2012 Splinting a healing touch for an ailing periodontium. *J. Oral Health. Commun. Dent.*. A Review Article. September-2012; **6** 145-8.
[33] Jin and Cao 1992 Clinical Diagnosis of Trauma from Occlusion and Its Relation with Severity of Periodontitis. *J. Clin. Periodontol.*
[34] Chandrasekaran, Manisundar and Padmanabhan 2012 Tooth splinting using fiber reinforced composite-metal a comparison. *Indian. J.Multidiscipl. Dent.*, August-Oct 2012; **2** 592-7.