The Relationship between Root-Crown Ratio of First Molar's Teeth with Trauma from Occlusion

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Abstract

Root-crown ratio is an important feature in the prognosis of teeth. The unbalanced root-crown ratio can be a factor of trauma from occlusion, which diagnosed subjectively through the radiographic examination. This study was conducted to confirm the subjective assessment into objective assessment. The aim of this study was to determine the clinical root-crown ratio of first molar which cause trauma from occlusion.

Measurement root-crown ratio using method of Lind and its modifications to measure the decrease in alveolar bone height. The mean of clinical root-crown ratio for maxillary first molar is 0.814±0.308, and for mandibular first molar is 0.741±0.295. There are four categories of clinical root-crown ratio based on ROC curve test, which are: ratio >1.51=good; 1-≤1.50= pretty good; 0.51-0.99= poor; ≤0.50= very bad.

Significant result of the correlation between clinical root-crown ratio with: gingival recession (rs:-0.221 on mesial, -0.266 on buccal and -0.179 on lingual/palatal); loss of attachment (rs:-0.340 on mesial, -0.427 on buccal, -0.295 on distal and -0.382 on lingual/palatal); tooth mobility (rs:-0.358) and the thickening of lamina dura (-0.252).

There is a relationship between clinical root-crown ratio of maxillary and mandibular first molar with trauma from occlusion that aggravated periodontitis.

Clinical article (J Int Dent Med Res 2017; 10(2): pp. 265-269)

Keywords: Root-crown ratio, first molar teeth, trauma from occlusion, periodontitis.

Received date: 28 September 2016 **Accept date:** 29 October 2016

Introduction

Periodontitis can be aggravated by trauma from occlusion caused by poor root-crown ratio and it's included in secondary trauma from occlusion.[1] The periodontal tissue adaptive capacity to withstand occlusal forces becomes less, and led to a decrease of attachment areas so it will increase the vulnerability of the remaining tissue to get injure.[2,3] Traumatic occlusion can cause damage to the bone, periodontal ligament, and the root. When the periodontal tissue can still accommodate the occlusal forces, the changes that occur are reversibel.[3,4]

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The anatomical root-crown ratio measured by the length of the tooth root (from the cervical line to the tip of the root) and the length of the crown (from the cervical line to the tip of the cusp or the highest part of the incisal edge). For example, the average length of the roots of the maxillary central incisor are 13.0 mm and 11.2 mm length of the crown, the root-crown ratio is 13 divided by 11.2 is 1.16. This ratio approaching one, indicating that the root of the tooth is not longer than a crown. The ratio of the root-crown of the normal maxillary first molar is 1.72 and the mandibular first molar is 1.83.[5]

The diagnosis of traumatic from occlusion caused by poor root-crown ratio and aggravate periodontitis do by subjectively through radiographic image to see the widening of periodontal ligament space, the discontinuity and thickening of the lamina dura. This study was conducted to confirm the subjective assessment into objective assessment.

Materials and methods

This research has been getting ethical clearance letters from Faculty of Dentistry, Universitas Indonesia, Number: 17/Ethical Clearance/FKGUI/IV/2014, using observational retrospective design on medical record of Periodontia Clinic. In this study using a periapical radiograph from patients with localized chronic periodontitis, general chronic periodontitis and aggressive periodontitis with maxillary or mandibular first molar have been trauma caused by poor root-crown.

The parameter of trauma from occlusion are: gingival recession, loss of attachment, tooth mobility and thickening of the lamina dura.[2] The inclusion criteria are for maxillary and mandibular first molars which have the parameters mentioned above. The exclusion criteria for maxillary and mandibular first molars were used as: abutments, full crown porcelain / acrylic / metal, including undergo migration, malposition, edge-to-edge occlusion and non-vital teeth.

Sample size determination by simple random sampling method in all cases of traumatic occlusion aggravate periodontitis since 2010-2014, the number of samples based on a single sample size formula obtained 97 samples.

Material in this study are: periapical X-rays, medical records of Periodontia Clinic of Dental Hospital, Faculty of Dentistry, Universitas Indonesia, and cephalo-tracing paper (RCF: 630-020, Ortho Organizers, Inc). The tools used are: digital cameras, x-ray films viewer size: 40x45x8 cm, cephalometric protractor/tracing template (Ormco Sybron), triangle ruler 60^0-90^0-30^0, and triangle ruler 45^0-90^0-45^0, straight ruler 15cm and mechanical pencils 0.5mm-2B.

The root-crown ratio, radiographically calculated based on: (1) the anatomical root-crown ratio, using methods of Lind (1972), and (2) the clinical root-crown ratio using a modification methods of Lind (1972), as measured by the ratio of the anatomical root-crown ratio, root length is minus to the height of alveolar bone loss, and a measured of crown added to alveolar bone loss height, in order to obtain the ratio of clinical root-crown ratio radiographically (Figure 1, 2). The dependent variable include: the anatomical root-crown ratio, bone loss height, and clinical root-crown ratio. The independent variable is a medical record includes tooth mobility, pocket depth, gingival recession, and loss of attachment. Statistical analysis includes univariate analysis, Spearman correlation test, Mann-Whitney test and determination of the cut of point using ROC-curve analysis.

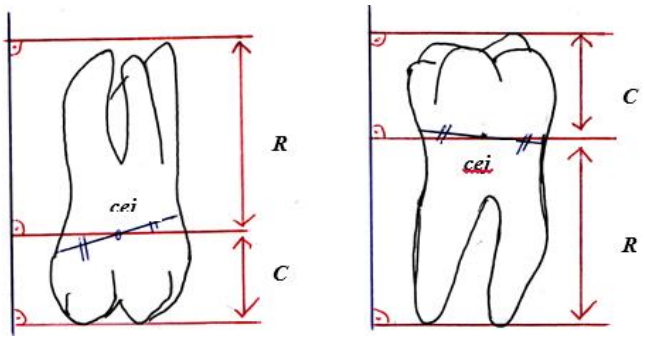

Figure 1. Radiographically, Anatomical Root-Crown Ratio Measurements on the Maxillary and Mandibular First Molar by Lind Method (C: Crown height; R: Root length, CEJ: Cemento-Enamel Junction)

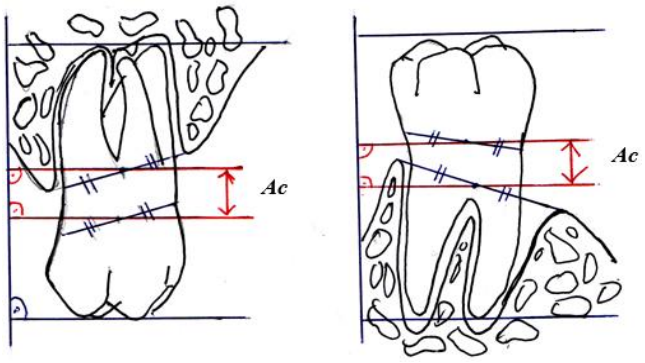

Figure 2. The Measurement of Alveolar Bone Loss Radiographically on The Maxillary and Mandibular First Molar by (Ac: alveolar bone loss height from CEJ to alveolar crest/pocket base)

Results

There are 183 samples of first molar periapical radiographs, divided into 96 maxillary first molar teeth, and 87 mandibular first molar teeth. A mean age of patients were recruited are 42.99±10.49 years old. OHIS index ranging from 0.1 up to 6.00 with a mean 1.46±3.138. In Table 1 we can see the distribution of the anatomical and clinical root-crown ratio of the maxillary and mandibular first molar.

To get a cut of point of root-crown ratio, ROC-curve test were taken, with the state variables are: tooth mobility and thickening of the lamina dura and obtained the cut of point of

anatomical root-crown ratio mean is 1.509. The cut of point of clinical root-crown ratio mean is: 0.51. Based on the cut-off point above, the mean ratio of the anatomical root-crown ratio can be categorized as follows: >1.50 = good; 1- ≤ 1.50 = pretty good; and the clinical root-crown ratio can be categorized as follows :> 1.50 = good; 1- ≤1.50 = pretty good; 0.51- 0.99 = poor; and ≤0.50 = very bad (Figure 3).

Ratio	N	Min-max	Mean (SD)
The anatomical root-crown			
Maxillary first molar	96	1.33-2.68	2.012 (0.277)
Mandibulary first molar	87	1.38-3.20	2.009 (0.309)
The clinical root-crown:			
Maxillary first molar	96	0.11-1.72	0.814 (0.308)
Mandibulary first molar	87	0.19-1.48	0.741 (0.295)

Table 1. Distribution of Mean, Minimum-Maximum, and Standard Deviation of Root-Crown Ratio of the Maxillary and Mandibular First Molar

Clinical root-crown ratio	Gingival Recession			
	Mesial	Buccal	Distal	Lingual/palatal
rs	-0.221**	-0.264**	-0.141	-0.179*
p	0.003	0.000	0.058	0.015

Spearman correlation test, rs = Spearman correlation coefficient; p: significance level, ** Correlation significant at α: 0.01, * Correlation significant at α: 0.05.

Table 2. Correlation between Clinical Root-Crown Ratio with Gingival Recession.

The results of Spearman correlation test between the clinical root-crown ratio with gingival recession, loss of attachment, tooth mobility and thickening of the lamina dura can be seen in Table 2, 3 and 4.

Clinical Root-Crown Ratio	Loss of Attachment				
	Mesial	Buccal	Distal	Lingual/palatal	Mean
rs	-0.340**	-0.427**	-0.295**	-0.382**	-0.450**
p	0.000	0.000	0.000	0.000	0.000

Spearman correlation test, rs = Spearman correlation coefficient; p: significance level, **Correlation significant at α: 0.01, *Correlation significant at α: 0.05.

Table 3. Correlation between Clinical Root-Crown Ratio with Loss of Attachment.

Clinical Root-Crown Ratio	Tooth Mobility	Thickening of the Lamina Dura
rs	0.335**	0.252**
p	0.000	0.001

Spearman correlation test, rs = Spearman correlation coefficient; p: significance level, ** Correlation significant at α: 0.01, *Correlation significant at α: 0.05.

Table 4. Correlation between Clinical Root-Crown Ratio with Tooth Mobility and Thickening of the Lamina Dura.

That tables showed the increase in the recession and loss of attachment will be followed by a decline of clinical root-crown ratio and there is a relationship in weak level with tooth mobility (rs=0.335; p=0.000) and thickening of the lamina dura (rs=0.252; p=0.001). The test results indicate there is a relationship between clinical root-crown ratio of maxillary and mandibular first molar with trauma from occlusion which aggravate periodontitis.

Discussion

The anatomical root-crown ratio never changed. In this study, the mean of root-crown ratio of the maxillary first molar tooth is 2.012±0.277 and the mean of root-crown ratio of mandibular first molar is 2.009±0.309. Compared with the study of Yun et al., on healthy Korean population, the root-crown ratio of the maxillary first molar, men (1.4051±0.19367); women (1.4167±0.21425); mandibular first molar, men (1.6274±0.19424) and women (1.6489±0.18791)[6], showing the root-crown ratio of maxillary and mandibular first molar on Yun et al. study are lower than this research.

Othman et al. research on Malay population, the root-crown ratio of the maxillary first molar, men (1.91±0.38) and women (1.86±0.34), while the root-crown ratio of mandibular first molar, men (2.42±0.33) and women (2.48±0.35)[7], showing the root-crown ratio of maxillary first molar are lower than this study, but the root-crown ratio of mandibular first molar are higher. The information of root-crown ratio in different ethnic groups is very limited, so that the average of the root-crown ratio on Korean ethnic group (Korea) and Malay (Malaysia) cannot be used directly in a population derived from other ethnic groups. Panoramic radiographs were using in Yun and Othman research. Grossman and Sadan (2005) in his paper wrote that Pepelassi and Diamanti-Kipioti advised to use periapical radiographs to detect the alveolar bone damage and they state that the result is better than the panoramic radiograph. Measurement of bone loss and the root-crown ratio with panoramic radiograph cannot accurate as periapical radiographs.[8]

Othman et al.[7] in his research, wrote that according to Asgarifar (2001) determination of cement-enamel junction (CEJ) to distinguish the root and the crown of the tooth, on the panoramic

radiographs are not so clear. Besides the difficulties of using the panoramic radiograph is on identify the reference points of the occlusal plane and the tip of root, it will increase the misidentification landmark. Therefore, the radiographic evaluation of the root-crown ratio should be use the periapical radiographs.[8] Prosthodontic view of root-crown ratio has been always associated with the ability of the tooth to be an abutment, which ideally the ratio between crown and root is 1:2. Shillingburg et al. in Grossman and Sadan[8] suggested for teeth abutments, the ratio between crown and root is 1:1.5, it is an optimum ratio and the minimum ratio is 1:1. Based on this references, the determination of cut points 1.508 as the basis for the anatomical root-crown ratio with categories: good (≥1.51 ratio) and pretty good (ratio 1-1.5) is appropriate.

Anatomically, area of root attachment depend on root length, number of roots and tooth root diameter ranging from CEJ to the apex which determine the resistance of teeth against the occlusal force and others forces, especially when they are given force in a lateral direction or buccal-lingual.[5] The measurement result of the root-crown ratio in this study showed a huge difference when compared to the anatomical root-crown. The root-crown ratio may increased from time to time, as a result: lost of the alveolar bone support; increasing of the fulcrum in crown part (arm effort), and the decrease of root part (arm resistance). The center of rotation moves to the apical, and the teeth become more vulnerable to the worse effects of laterals forces.[5] All of these will worsen the clinical condition such as mobility, development of dental caries and hypersensitivity on exposed root surface. [9]

In practice, a dentist should be able to distinguish the clinical signs and symptoms of trauma from occlusion and periodontitis. Increasing in probing, greater than 3mm is clinical signs of periodontal disease. When the probing depths more than 5mm, indicating there has been a breakdown of bone and periodontal ligament, this condition is known as periodontitis. In periodontitis will found: gingival and periodontal ligament fibers damage, alveolar bone loss and migration of epithelial junction to apical and such damage are described as a loss of attachment. Measurement of loss of attachment, are a combination of gingival recession and pocket depths. Measurement of periodontal destruction is more accurate use loss of attachment than the pocket depth.[5,10,11]

An excessive occlusal force may be a factor that causes gingival recession. Kundapur et al. in his study wrote that Box (1930), Miller (1934) and McCall (1921) state that the cause of the recession is periodontal tissues trauma as a result of occlusal interference. They have claimed that the teeth showing gingival recession, have the clinical signs and symptoms of trauma from occlusion.[12] In this study indicate that gingival recession are in mesial about 1-8 mm (31.1%), buccal about 1-6 mm (44.8%), distal about 1-6 mm (32.8%), and the recession in the lingual / palatal about 1-10 mm (60.1%). The lost of periodontal support tissues, can be the subject of secondary traumatic occlusion, so that "the normal occlusal force" may cause trauma to the tooth apparatus attachment, which can cause a significant tooth mobility.[13,14] Excessive force can cause pathological changes in periodontal ligaments. Trauma from occlusion, form a tension and compression in the periodontal ligament may lead to widening periodontal space.[14,15] Destruction of periodontal fibers occurs in the injury stage of trauma from occlusion and a widening of periodontal ligament occurs in the final stage, which also leads to increased tooth mobility. Increasing the width of the periodontal space, often accompanied with a thickening of the lamina dura.[10] Widening of the periodontal space can also be seen on mobile teeth, although not accompanied with vertical or angular bone resorption and without an increase in pocket depth.[3,15]

Conclusions

The poor or unfavorable relationship between root-crown ratio of first molar's teeth can cause trauma from occlusion that aggravate periodontal disease.

Acknowledgements

We thank to the Universitas Indonesia for the support.

Declaration of Interest

The authors report no conflict of interest.

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