

Research Article

Influence of Class 2 Leverage of Lower Free-end Denture toward Bone Resorption by Using Panoramic Radiographic

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Abstract:

Lower free end denture is a denture which one or two saddle end that replaced posterior natural teeth. Free end denture becomes unstable due to difference in compressibility between supporting mucosa which can affect its health.

The purpose of this research is to ascertain the influence of design class 2 leverage of metal framework free end denture toward bone mandibular resorption and supporting bone alveolar after wearing denture for 3 months. This research is a clinical experimental on 20 male and female subjects within age of 30-60 with bilateral and unilateral free end mandibular which fulfilled class 2 leverage of metal framework partial denture's inclusion criteria. Height of bone mandibular and supporting alveolar bone were measured by using panoramic radiographic from January-March 2018. The data was being analyzed by using t paired test and Wilcoxon test.

The result showed resorption of significant bone was found with class 2 leverage design on mesial ($p=0.010$), midline ($p=0,001$), distal ($p=0,000$). Resorption of significant supporting alveolar bone was also found ($p=0,012$). The result corresponds with other research which stated resorption of bone was found after wearing a denture. The conclusion stated that this class 2 leverage of retainer will influenced in increasing resorption of mandibular bone and supporting alveolar bone with free end of metal framework denture.

Keywords: Class 2 leverage retainer design, resorption of mandibular bone, resorption of supporting alveolar bone, panoramic radiograph.

I. Introduction

The purpose of denture is to improve function of chewing, phonetics, esthetic, and maintain surrounding mucosa's health¹. The design of denture must be planned very carefully in order to maintain the health of mucosa, supporting tissue, density of bone, and mobility of abutment teeth.² Improving better life by restoring function and esthetic is one of the most important purpose in rehabilitating patient with partial denture especially elder patient.³ Gender, descendant, systemic condition, sequence of losing teeth, long lost teeth and other idiopathic factors may influence chronic resorption process in edentulous area.^{1,2,4}

Curtis et.al did their survey and found out the variety of prevalence of Kennedy classification in North America which 40% Class I Kennedy case, 33% Class II Kennedy, 18% Class III Kennedy, and 9% Class IV.^{4,5} The highest case for mandibular is Class I Kennedy which is about 49% and for maxilla is Class II Kennedy which is 38%.^{4,5}

Metal framework denture is one of type of removable partial denture which is excellence compared to acrylic denture; can be made thinner, rigid, channel heat, and chewing force can be transferred evenly to supporting tissue and mucosa.^{4,5}

Mandibular free end denture is a denture which one or two saddle end extended to posterior region and supported from natural teeth or ridge mucosa.¹ Free end denture with distal extension is quite difficult compared with all tooth supported denture.^{1,5} The main problem of free end denture is its

instability of denture which easily shift and tipped up.¹ This free end denture get supported by other natural teeth and mandibular ridge mucosa until there is a big difference in compressibility between posterior edentulous free end region and its anterior which caused its instability.^{1,6}

Big differences of forces between anterior and posterior region and missing a lot of teeth which give big impact to denture and mucosa.⁶ Differences in compressibility of good support between mucosa to mucosa, or between mucosa and abutment tooth's periodontal supporting which causes artificial teeth on saddle area was impacted by forces and exerted toward apical which depends on magnitude and transmission of chewing forces due to large difference in compressibility and length of saddle.^{1,2,6}

There are 2 types of leverage of free end case; Class 1 and class 2 leverages.^{1,6} Class 1 leverage occurs when fulcrum point across between retention point and chewing force and the forces push denture toward apical which causes its retentive arm and abutment teeth tilted toward occlusal.^{1,5,6} Class 2 leverage occurs when retention point and chewing force are parallel with fulcrum point or line.^{5,6} This happens where one saddle end pushes toward apical and so its retentive arm due to chewing forces which makes the denture not tilted. However, this design makes denture become more unstable compared to class 1 leverage because all the forces toward apical are fully supported by mandibular bone.^{4,5}

The unstable denture which later causes problem of other

tissue's health.¹ The unstable free end denture will causes the resorption of mandibular bone become faster.⁵ Missing distal teeth in mandibular cause disturbance in neuromuscular system, reduce biting forces and vertical dimension of denture which affect on height of mandibular bone.^{5,6} Big leverage of denture causes periodontal abnormalities in abutment natural teeth.^{4,6} The retainer end of class 2 leverage still under survey line which does not make the denture tilted during chewing.^{5,6} Removable partial denture should distribute the forces evenly and gains optimal support which can protect abutment teeth and mandibular bone.^{4,5} Bone resorption mostly occur in mandibular which mainly caused by factors such as anatomy, function of prosthesis, and should be considered of muscle capability.⁷

The application of panoramic radiography is one of the ideal pre-prosthesis examination and be used as supporting examination which resorption of mandibular and maxillary can be seen.⁸ Measurement of reference point of mandibular in radiography are mental foramen, mandibular canalis and bottom edge of mandibular while reference point of maxilla are bottom edge of orbital and zygomatic process point.^{6,8} A. Ozan et.al⁷ did their research which was about free end denture case that compared between acrylic partial denture patient and Class 2 leverage retainer design and found out that there was reduction of bone height in horizontal or vertical compared to patient without denture.⁸ In Talgren's research, he found out that the resorption of mandibular bone of free end denture patient varies with duration of wearing the denture.^{9,10} Canger did his research and found out that there was reduction of bone height after wearing Class 2 leverage retainer design with free end denture.^{11,12}

Based on problem background above, an author is interested to conduct a research about magnitude of resorption of mandibular bone and abutment teeth alveolar bone after wearing metal framework free end partial denture and the outcome clinical data can be consideration in choosing types of partial denture which can be used to anticipate in constructing a new denture after knowing its clinical condition.

II. Material and methods

Type of this research was clinical experiment design with *pre-test & post-test group* approach. The purpose of this design was to discover the magnitude of resorption of mandibular bone and abutment teeth alveolar bone after wearing metal framework of mandibular free end denture with Class 2 leverage retainer design. 20 sample of this research were obtained in Prosthodontics Clinic in Unpad by using *purposive sampling* method and design *pre and post* with metal framework free end denture worn for minimal 3 months with good health conditions. Time taken for obtaining patient by using sampling method was between January-March 2018.

Characteristics of subjects in this research was consisted of 38,446% male and 61, 45% female. Amount of bilateral edentulous posterior case was 53, 84% while unilateral edentulous posterior case was 46, 16%. Estimation of statistic test had been done on mesial, midline and distal of missing

second lower molar and abutment teeth.

Measurement of resorption of mandibular bone height was done and being measured by using Eziplus software. Position of both molar was being done by using standard mean of size of teeth. Height of alveolar bone and mandibular canalis in second molar region were being measured on patients with metal framework free end partial denture.

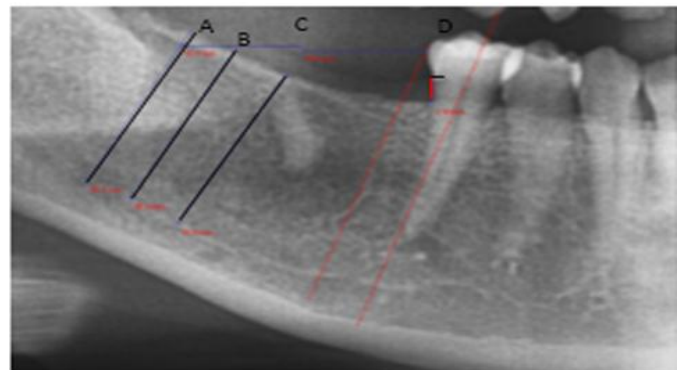


Figure 3.1 Measurement of resorption of mandibular bone with EziPlus

- A. Measurement from alveolar crest to distal mandibular canalis of second molar
- B. Measurement from alveolar crest to midline mandibular canalis of second molar
- C. Measurement from alveolar crest to mesial mandibular canalis of second molar
- D. Measurement from CEJ to alveolar crest bone of abutment teeth

The analysis should be consistent with type of research problem and its data. Numeric data should be tested first with Normality test by using Shapiro-Wilk test due to amount of data less than 50 which was used to know whether this data was normally or abnormally distributed. Significance test was used to compare the characteristic of both research groups, if the data was distribute normally then unpaired t test was being used. If the analysis result showed the data was abnormally distributed, the data will be transformed by using logarithm transformation. If the transformation has been done but there is indifference in data, non-parametric statistic will be used. Wilcoxon test will be used as alternative test if the data was abnormally distributed.

Significant criteria used as value p as criteria become significant when $p \leq 0,05$ or become insignificant when $p > 0,05$.

III. Result

20 tested samples were given minimum resorption score with 12,4, maximum score 21,7%, mean 17,5 and standard deviation 2,4 on mesial side before their treatment. After given treatment, the minimum resorption score on mesial side vary to 9,4, maximum 21,9, mean 16,4 and standard deviation 3,2 (Table 1).

Table 1 pre-test and post-test of height of mandibular bone on mesial side

	<i>N</i>	<i>Min</i>	<i>Max</i>	<i>Mean</i>	<i>Std. Deviation</i>
<i>Pre test</i>	20	12,4	21,7	17,5	2,4

<i>Post test</i>	20	9,4	21,9	16,4	3,2
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The result of comparison test of height of mandibular bone on mesial side between before and after treatment showed that p-value was 0,010. Since p-value less than 0,05, there is a significant difference in resorption of bone on mesial side with mandibular metal framework free end denture with Class 2 leverage retainer design (Table 2).

Table 2 Comparison test of height of mandibular bone on mesial side pre-test and post-test with t test

	Rerata (SD)	<i>p-value</i>	Conclusion
<i>Pre test</i>	17,5 (2,4)	0,010*	significant
<i>Post test</i>	16,4 (3,2)		

Table 3 pre-test and post test of height of mandibular bone on midline side

	<i>N</i>	<i>Min</i>	<i>Max</i>	<i>Mean</i>	<i>Std. Deviation</i>
<i>Pre test</i>	20	11,8	21,7	16,8	2,7
<i>Post test</i>	20	8,9	21,5	15,7	3,2

Based on the table above, the minimum score of 20 tested sample before treatment on midline side was 11,8, maximum 21,7, mean 16,8, and standard deviation 2,7. After treatment, the minimum score on midline side was 8,9, maximum 21,5, mean 15,7 and standard deviation 3,2.

Table 4 Comparison test of height of mandibular bone on midline side pre-test and post-test with t test

	Rerata (SD)	<i>p-value</i>	Conclusion
<i>Pre test</i>	16,8 (2,7)	0,001*	Significant
<i>Post test</i>	15,7 (3,2)		

Based on the table above, the value of comparison test of height of mandibular bone on midline side before and after treatment showed that p-value was 0,001. Since p-value less than 0,05, there is significant difference in resorption of mandibular bone on midline side with mandibular metal framework free end denture with Class 2 leverage retainer design.

Table 5 Pre-test and Post-test of height of mandibular bone on distal side

	<i>N</i>	<i>Min</i>	<i>Max</i>	<i>Mean</i>	<i>Std. Deviation</i>
<i>Pre test</i>	20	0,0	23,9	16,1	4,9
<i>Post test</i>	20	9,7	23,5	15,7	3,6

Based on the table above, the value of minimum score before treatment on distal side was 0,0, maximum 23,9, mean 16,1 and standard deviation 4,9. After treatment, the minimum

score on distal side was 9,7, maximum 23,5, mean 15,7 and standard deviation 3,6.

Table 6 Comparison test of height of mandibular bone on distal side pre-test and post-test with Wilcoxon test

	Mean (SD)	<i>P-value</i>	Conclusion
<i>Pre test</i>	16,1 (4,9)	0,000*	Significant
<i>Post test</i>	15,7 (3,6)		

Based on the table above, comparison test of height of mandibular bone on distal side before and after treatment showed that p-value was 0,000. There is significant in different in resorption of mandibular bone on distal side with mandibular metal framework free end denture with Class 2 leverage retainer design since p-value <0,05.

Table 7 Pre-test and Post-test of Height of alveolar bone of abutment teeth

	<i>N</i>	<i>Min</i>	<i>Max</i>	<i>Mean</i>	<i>Std. Deviation</i>
<i>Pre test</i>	20	0,0	6,0	3,6	1,6
<i>Post test</i>	20	1,9	7,0	4,4	1,5

Based on the table above, the minimum score of abutment teeth before treatment was 0,0, maximum 6,0, mean 3,6 and standard deviation 1,6. After treatment, minimum score of abutment teeth was 1,9, maximum 7,0, mean 4,4 and standard deviation 1,5.

Table 8 Comparison test of height of alveolar bone of abutment teeth pre-test and post-test with t test

	Rerata (SD)	<i>p-value</i>	Conclusion
<i>Pre test</i>	3,6 (1,6)	0,012*	Significant
<i>Post test</i>	4,4 (1,5)		

IV. Discussion

These results showed that there is influence of mandibular metal framework free end denture with Class 2 leverage retainer design toward resorption of mandibular side on mesial side (p=0.010), midline (p=0,001), and distal (p=0,000). Resorption of bone occurs due to leverage suppresses the supporting tissue below saddle biomechanically when there is leverage channeled toward apical and lateral on the posterior.^{2,10} Mandibular free end with Class 2 leverage retainer design concentrates more on the free end posterior which caused heavier load on that side and resorption of mandibular bone occurs.^{2,4} Constant stimuli in bone tissue can preserve bone remodeling through osteoclast and osteoblast activities.⁹ Due to heavier load, inflammation on mucosa can causes decreasing in blood supply, increased of osteoclast, and increased of organic enzyme bone which made resorption of mandibular bone become faster.^{11,12}

Retentive arm of Class 2 leverage design was located on distal

side of abutment teeth. By the time force was applied to apical, the retentive arm also follow until there is no leverage on abutment teeth.^{1,2} However, if the force were supported fully by mandibular bone, blood supply reduced due to continuous suppressed and osteoclast cell become active which caused height of alveolar bone easily to reduce.^{21,22}

There was significant resorption of mandibular bone in this research after worn mandibular metal framework free end denture with Class 2 leverage retainer design. The result was correspond with other research which had been conducted by Ozan et.al which stated that there was a significant resorption of mandibular bone and alveolar bone of abutment teeth if compared to those without denture.

Continuous and magnitude of mechanical force is quite harmful which can caused mucosa ischemic and variety of ulcer. Maximal value of pain threshold is 275kPa based on a few authors.^{33,34} Other study stated that application of heavy forces on soft tissue and blood vessel can induce resorption of alveolar bone and mandibular bone.³⁴ Other study showed that forces within 50-150 kPa reduce the significant in blood perfusion which is in ± 20 seconds. Other researcher also considered the forces between 67,5-90,8 kPa is quite harmful to mucosa surfaces.³⁵

A design of removable partial denture should be determined to distribute chewing forces evenly between abutment teeth and mandibular teeth. The design of partial denture which does not considered the biomechanics principle can cause increased abutment tooth mobility or can contribute to resorption of mandibular bone under the denture.³⁰

Extension and direction of movement of partial denture during function can be affected by supporting structure and design of prosthesis.²⁰

Denture with mucosa support usually become a cause of ulcer, however, it more contributes to abrasion compared to ulcer in dentistry.^{23,24} Instability of denture and mucosa support become main cause of wound in the mucosa and feel uncomfortable especially with saliva disturbance. Instability of denture become great when the denture is not fitting to mucosa surfaces.²² Extend of damaged mucosa which is produced by the forces of clasp of denture around 0,1-0,3 mm which compatible to 5-20% strain, depending on mucosa rigidity.^{23,24} Greater displacement or similar with mucosa thickness can be occur due to combination from displacement of denture on supporting tissue and mucosa damage.^{22,24} Extended of damaged mucosa which is caused by clasp of denture that exceeded the thickness of mucosa membrane. Severe damage on the thickness of mucosa can be caused by small area burden that susceptible with distortion, for example, elasticity determination.^{20,24} Compagnoni et.al assumed that displacement of denture can be measured for mucosa damaged because significant damage degree can be observed to determine the extent of damage during research.^{22,25} Denture which support chewing forces evenly on supporting tissue and chewing convenience can be accepted even its utilization is not even reflected by the measurement of chewing efficiency. Feeling pain and uncomfortable will be occur under the denture as transferring chewing forces.²⁰

Bone will be responded by receiving and stabilizing the mass and normal density when forces in its tolerance limit.¹¹ Osteoid tissue will receive constant mechanical stimuli about the balance between osteoclast and osteoblast activities. Mucosa inflammation which is caused by suppression of tissue under the saddle denture can cause resorption of bone through formation of arachidonic acid metabolite or interleukin.^{4,5} Resorption of bone is faster than remodeling as resorption process is the first response when the bone received mechanical stress.³⁴

Osteoclasts and osteoblast process in alveolar bone are working well-balanced when teeth still exist, however, missing teeth caused the bone could not receive enough mechanical stimuli and disturbance in bone metabolism occur which increased osteoclast stimuli and decreased osteoblast and cause resorption of alveolar bone.^{5,6} Other than that, if the occlusal mechanical forces reduced, so as the amount and thickness of trabecular.¹⁸ This process will cause degradation in height of ramus and height of mandibular condyles. This condition occurs due to disturbance in remodeling process of mandibular condyle on edentulous region which unavailable to adapt and support structure and normal function of

temperomandibular joint.^{3,5} Missing teeth causes osteoblast become inefficient in producing bone formation, aging process in women cause reduction of estrogen production as well as calcium absorption process from bowel also can cause resorption of alveolar bone which can affect mandibular morphology changes.³³ When activity of edentulous bone reduced, mechanical stimuli also reduced and stimulate more osteoclast productions.^{12,13} The previous study discovered that degree of resorption of bone is greater in early stage and slowed down in the next step.³⁰ Similar research showed that mean 23,09% reduced from height of mandibular during the first 5 years period: 5 to 10 years onwards showed that reduction of height of ridge around 26,05% and the next 10 years showed some improvement which is around 5,61%.³¹ Mechanical load in bone can cause mechanical stress and strain or resultant tissue deformation which affect on bone tissue which is bone formation on periosteal surface and reduce bone turnover to alleviate bone absorption. Forces that not exceeded normal line can restore the measurement shape and strength of bone tissue by repairing density and architecture of bone. Bone carry out mechanical adaptation which is a cellular process that needs biological system that can detect mechanical burden.^{28,34}

Early osteoclastogenesis stadium process will go through one channel that requires mediators which are cytokine and stimulator colony factor. Cytokine mediator that stimulates osteoclastogenesis consist of IL-1, IL-3, IL-6, Leuke, is Inhibitor Factor (LIF), while cytokine mediator that inhibit osteoclatogenesis consist of IL-4, IL-10, IL-18, and Interferon G. Interleukin 6 is one of the cytokine which has important role where increasing of IL-6 can hold off a few disease that may affect bone remodeling and absorption of local or systemic excess bone.

The result showed that there is a significant in resorption of

alveolar bone of abutment teeth ($p=0,012$). This result corresponds with Canger's research³¹ which stated there was reduction of alveolar bone of abutment teeth after worn Class 2 leverage retainer design with free end denture.^{11,12} Free end edentulous case, occlusal forces was being received by mucosa under saddle and abutment teeth.^{11,12} Difference in compressibility on mucosa surface causes friction between denture and retainer. .^{13,14} Continuous force that exceeded tolerance limit can cause damage on periodontal tissue of abutment teeth and stimulate osteoclast which causes resorption of alveolar bone.^{12,13}

Three fulcrum line that influence forces on free end denture which extended through two abutment teeth on each sides. Big rotation movement surrounding the tooth axis, but not harmful.^{22,23} Forces that applied on long axis of teeth will more resistant compared to the force that not applied on long axis of teeth.

Forces that produce torque on abutment teeth with free end denture take place because free end prosthesis produces rotation force and detached due to leverage force.²⁸ Definition of torque shows the stress which tend to rotate and manipulate abutment teeth to lateral and proximal side.^{28,29} Movement to lateral become wider from extension of base when alveolar ridge become low and more severe when there is flabby tissue surrounding alveolar ridge.²⁸ Torque force become bigger and harmful when there is large chewing load, abutment teeth with round shape and pointed root, single root and abutment teeth which has history of damaged alveolar bone, a few teeth left and patient with history of bruxism.³⁰

When force line direct toward lateral line of abutment teeth root, the force will be direct vertically toward periodontium, if the force toward lateral, it will cause tipping on abutment teeth. Rotation axis can be changed by designing partial denture that can compensate the direction and greater forces on abutment teeth and mandibular bone.^{22,23}

Good support from distal extension of denture can be obtained by taking secondary impression on alveolar ridge.³ Altered cast impression technique can be used for minimalizing difference in supporting compressibility between abutment teeth and surrounding tissues. Besides that, this technique helps in spreading forces equally on free end region and helps increased stability of denture.^{3,4,5} With equally distributed forces, altered cast impression technique also gives another benefit which maintains alveolar ridge from excess resorption of bone and reduced leverage on abutment teeth. Other than that, necessity of adaptation of denture after insertion is being reduced as well as number of visits and the patient's comfort also increased. This also increased patient's satisfaction with denture.^{3,5}

Benefit of panoramic radiography is to present features bone and teeth extensively, its radiation dosage lower, comfortable for patient, suitable for patient who has difficulty in opening mouth/trismus or patient who cannot managed to do intraoral radiography, short estimation time which usually 3-4 minutes, helps in establish diagnostics which include bone jaw generally and evaluation on trauma, and development of teeth in mixed dentition stage.³⁷ Other than benefits above, using

modest radiography technique, cheap price and the outcome of the radiography also satisfied.^{37,39}

V. Conclusion

Based on the result which can be concluded that:

1. There is resorption of mandibular bone after worn Class 2 leverage retainer design with metal framework of free end denture where mean on mesial side is 1,1 mm, midline side 1,1mm and distal side 0,4mm of second molar.
2. There is resorption of alveolar bone of abutment teeth on patient with Class 2 leverage retainer design with metal framework of free end of partial denture where mean is 0,8mm.

VI. References

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