Original Work

Correlation between the Level of Periodontitis and Heart Disease
at Rural Area in the Kingdom of CambodiaTakashi Miyata ^{*1,2}, Uy Sophorn ^{*2}, Chan Borey ^{*2}, Sok Chea ^{*2},
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カンボジア王国, 村落地域住民における歯周炎レベルと心疾患の相関について

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Abstract : As members of the Organization of International Support for Dental Education (OISDE) , we had been implementing “the project of primary health care and prevention of systemic damages caused by periodontal infection at the rural area in the Kingdom of Cambodia”. This project was supported by Japan International Cooperation Agency (JICA) since March 2004 until March 2005. The targeted areas were composed of 7 provinces and 25 districts. The subjects were 1,296 residents. As one of the risk factors, living environment risk (LE) factor was charted based on a five-grade method according to our original classification. Systemic medical condition of the residents was charted by interview method into history of systemic diseases and history of tropical infections. The dental intelligence quotient (dental IQ) concerning periodontal infection was charted by question and answer method according to a five-grade classification. As part of behavioral risk factor for periodontal inflammation, the number of frequency of brushing the teeth was evaluated using interview method. The level of periodontitis was evaluated by periodontal probing using the four-point method and bleeding on probing (BOP) for all remaining tooth/teeth in each resident. The medical examination, which includes heart murmurs, lung sounds, blood pressure, urine test, and electrocardiogram (ECG), was investigated by a physician. In the result, 29% of the residents were discovered with abnormal heart murmur or ECG findings. These comprised 34% mitral valve murmur, 18% tricuspid valve murmur, and 16% other abnormal heart sounds. The ECG findings in the residents with abnormal heart findings revealed 23% due to premature

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atrial contraction, 14% atrio-ventricular (A-V) Block, and 6% was caused by other abnormal ECG findings. The onset of heart disease was statistically different between the group with over 3.5 mm depth and the group with less than 2 mm depth when analyzed by t-test. In spite of the heart disease was detect in no BOP group of 20%, the heart disease was significantly tendency by statically analyze increasing according to over 20% of BOP. This result strongly considered that chronic periodontal inflammation has one of the caused damages to the heart valves and is influenced by bacteremia. Nihon Shishubyo Gakkai Kaishi (J Jpn Soc Periodontol) 48 : 208-217, 2006.

Key words : electrocardiogram, heart disease, Kingdom of Cambodia, periodontitis, rural area

要旨 : 我々は歯科医学教育国際支援機構のメンバーとして「カンボジア王国村落地域における歯周感染症による全身被害に対する予防とプライマリー・ヘルス・ケアプロジェクト」を JICA (独立行政法人・国際協力機構) の支援で 2004 年 4 月から 2005 年 3 月まで実施した。対象地域は 7 つの県, 26 のディストリクトで, 対象人数は 1, 296 名の住民であった。生活環境のリスク・ファクターは我々が開発した分類方法で 5 段階評価した。全身状態は問診によって既往歴および熱帯感染症について調査した。歯周感染症に関するデンタル IQ は質問形式で 5 段階評価した。また, PCR および歯ブラシの回数に対しても調査した。歯周炎レベルは 4 点法ブローピングおよび BOP を全ての対象住民の残存歯に対して実施した。メディカル診査は内科医により心雑音, 肺音, 血圧, 尿検査および心電図の測定を行った。その結果, 29% の住民に心雑音か心電図の異常波形が認められた。これらの内, 34% は僧坊弁雑音, 18% は三尖弁雑音そして 16% はその他の心雑音であった。心臓に異常所見のある住民の心電図所見では, 23% に心房性期外収縮, 14% に房室ブロックそして 6% にその他の心電図の異常波形が認められた。ポケットの深さの関係では 3.5 mm 以上のポケットがあるグループと 2 mm 以下のグループの間では統計学的検定 (t-test) で心疾患の発症に有意に差があった。BOP が認められなかった 20% のグループに心疾患が認められた一方, BOP が 20% を超えるに従って心疾患が増加する傾向が認められた。

キーワード : 心電図, 心疾患, カンボジア王国, 歯周炎, 村落地域

Introduction

It is considered that heart disease can be caused by several factors, including lifestyle, nutrition, living environment, and infection. Smoking is the prototype lifestyle factor, which affects a silent and gradual damage to the heart. A poor living environment also strong influences the onset of heart disease because of malnutrition and predisposition to infection.

According to evidence-based periodontal medicine, it has been a well-known fact that invasion of bacteria through ulcers located inside the periodontal pathological pocket subsequently leads to bacteremia and affects internal organs causing heart disease, ischemic stroke, respiratory disease, deterioration of diabetes, low birth weight, etc.¹⁻¹⁰⁾. A number of researches have been published regarding the risk factors contributing to crisis in periodontal disease. The consensus, based on a lot of reports, emphasizes biological risk factor and behavioral risk factor as the major influences to periodontal disease.¹¹⁻¹⁴⁾. How-

ever, the relationship between heart disease and presence of periodontal disease has not been investigated satisfactorily on a wider rural area.

We, the Organization of International Support for Dental Education (OISDE), had been implementing “the project on primary health care and prevention of systemic damages caused by periodontal infection at the rural area in the Kingdom of Cambodia”. This project was supported by Japan International Cooperation Agency (JICA) since March 2004 until March 2005. The targeted areas were composed of 7 provinces and 25 districts, and the subjects were 1,296 residents. The level of periodontitis was evaluated by periodontal depth using the four-point method and bleeding on probing (BOP). The medical examination, which includes heart murmurs, lung sounds, blood pressure, urine test, and electrocardiogram (ECG), were investigated by a physician. In the result, 29% residents had abnormal heart murmur or ECG findings. Thus, there is likely a strong correlation between abnormal heart findings and level of periodontal inflammation.

Material and Methods

Target area :

The targeted area of this study consisted of 7 provinces and 25 districts of the rural areas in the Kingdom of Cambodia. The actual data of each province is shown in Table 1. The number of investigated residents totaled 1,296.

Charted methods :

Basic individual information : The basic information of all visiting residents was charted according to name, sex, birth date, occupation, marital status, and number of children, including infant mortality for married females, based on our original concept.

Risk factors chart : Living environment risk (LE) factors were charted based on a five-grade method according to our original classification. The contents of LE include living place, sanitation especially toilet facility, safe water supply, and the condition of living in close proximity with the livestock. The concrete matters are shown on Table 2. Systemic medical con-

dition of the residents was charted by interview method into history of systemic diseases and history of tropical infections. The dental intelligence quotient (dental IQ) concerning periodontal infection was charted by question and answer method according to a five-grade classification. The question contents were calculated as follows : Point 1 : Do you have knowledge of periodontal disease? (term only) Point 2 : Do you know the symptoms of periodontal disease? Point 3 : Do you know how periodontal infection occurs? Point 3 : Do you know what a dental plaque or calculus is? The totally points were classified into five grades : grade 1 is 9 points, grade 2 is 6 points, grade 3 is 3 points, grade 4 is 1 point, and grade 5 is counted 0 meaning all answers are incorrect. As part of behavior risk factor for periodontal inflammation, the number of times of brushing the teeth was evaluated using interview method. These charted methods were reported in detail our previous paper 15).

The tooth brushing usage was also evaluated as behavioral risk factor by five-points method according

Table 1 The basic health sector data of the targeted area

Province	Operation district	Referral hospital	Health center	Covered population
Kondal	8	5	88	1,068,648
Kompong Thom (KT)	3	3	50	618,473
Takeo	5	5	70	854,727
Battambang (BTT)	5	4	74	843,990
Shihanuk Villa (SV)	1	1	11	147,653
Stung Treang (ST)	1	1	10	80,208
Svay Rien (SR)	3	3	37	478,230

Table 2 Evaluation items of the risk factors

Items of the risk factors	The contents of evaluation
Living environment	1. Living conditions 2. Sanitary condition 3. Safe water supply 4. Living with live stock
Systemic conditions	1. Systemic disease 2. History of tropical disease
Dental IQ	Understanding of periodontal disease
Tooth brushing behavior	How many times per day
Life style	Smoking Chewing nuts

to time of brushing a day. From grade 1 to 3 are meant at least brush teeth one time per day but grade 4 means once time brush teeth few days and grade 5 means never brush teeth.

Examination of periodontal conditions :

Following examinations were investigated for all visiting residents and all of the remaining tooth/teeth. Periodontal infection was evaluated by a four-point method in measuring periodontal pocket depth (PD). An instrument for periodontal probing was used the 2 mm interval collar code probe produced by Nordent Co. Active inflammatory periodontal pocket was examined by bleeding on probing (BOP). Plaque-induced gingival inflammation was evaluated by plaque control record (PCR method by O'Leary), which used a staining solution.

Medical examinations :

All of medical examinations were investigated by one Cambodian physician for all visiting residents. The medical examination consisted of physical examination of the heart murmur and lungs sound, blood pressure, urine test, and ECG. Heart murmur and lung sound were used by stethoscope. Measurement of blood pressure was used by a digital automatic sphygmomanometer that was produced by OMURON and product number is HEM-63L. Urine test was used stick type for protein, glucose and occult blood reaction that is produced by Terumo Co. uricase kc. ECG finding was used by pocket ECG monitor, WEC-7101 produced by Nihon Kohden Co..

Programs on prevention and enlightenment :

All visiting residents at the health center were informed of the possible systemic damages caused by periodontal infection according to our original program. Our original program is using as text book at Health Science University, Faculty of Odontostomatology, Phnom Penh, Kingdom of Cambodia. And in this project, this program was modified much more simple and plain for visiting residents.

Primary health care :

Scaling was done by dentists who were the staff of Health Science University, Faculty of Odontostomatology, Department of Periodontology for all visiting resident using ultrasonic scalar and hand scalar as needed for the periodontal disease condition.

Results

The number of targeted areas in this project covered 7 provinces and 25 districts, which included health centers and referral hospitals. Basic data of each province is shown in Table 1. The total of the targeted residents was 1,296. The numbers of males were 530 and females were 766. The age distribution of the targeted resident ranged from 18 to 72 years old and number of generation is shown in Table 3.

The condition of the living environment, dental IQ, and brushing behavior were arranged for each province as indicated in figure 1. Regarding living environment condition, almost all provinces scored between points 2 to 3, which means the targeted residents live in very poor living environment. Moreover, the subjects possessed very few knowledge about periodontal disease. However, 75% of the subjects had brushing behavior of once a day, except in the Kandal province. According to the data from corroborated watch program with WHO and UNICEF on 2003 in Kingdom of Cambodia, the sufficient rate of sanitary facility in the rural area was only 18%.

The situation of sanitary facility spread rate in our targeted provinces were less than average of the country with respect to the rural area, except in the Kandal province (Fig. 2).

In the Plaque Control Record (PCR) result, a very high value of over 80% registered in all provinces, especially in Stung Treng province. Regarding the result on the number of remaining teeth in each province, it was necessary to evaluate whether the missing teeth were due to dental caries/periodontal

Table 3 The number of subjects, distribution of sex and generation

Number of subjects	1,296	
Distribution of sex on visiting subjects	Number of male	530
	Number of female	766
Distribution of the generation on visiting subjects	Under 20's	134
	20's	312
	30's	370
	40's	240
	50's	156
	60's	62
	Over 60's	22

Fig. 1

Analysis of risk factors in each provinces

Risk factors had analyzed five points methods for Living Environment : LE, Dental IQ : DIQ, Tooth Brush Behavior : TBB.

Fig. 2

Actual condition of sanitary facilities spread. According to the data from corroborated watch program with WHO and UNICEF on 2003 in Kingdom of Cambodia, the sufficient rate of sanitary facility in the rural area was only 18%. However, the situation of sanitary facility spread rate in our targeted provinces was less than average of the country except Kondal province.

disease or extracted tooth/teeth by dentist or traditional dentist. Therefore, the circumstance that more remaining tooth could not always be associated with good oral condition. The close geographical relation of Kondal province to Phnom Penh could be a strong influential factor in the dental care situation because of accessibility to dentists or even traditional dentists.

However, in the result of BOP, a scattering of values among the provinces was registered. The scattering of BOP level ranged from 25% to over 40%. The

residents with normal periodontal condition, wherein the periodontal PD was less than 2 mm, 23% had heart disease. The group with over 2.5 mm depth denoted a significantly increased tendency to acquire heart disease, whereas in the group with depth of over 3.5 mm, 43% had heart disease. The onset of heart disease was statistically different between over 3.5 mm group and less than 2 mm group when analyzed by t-test. In spite of the heart disease was detected in no BOP group of 20%, the heart disease was

Fig. 3

34% from among detected cardiac murmur finding residents were indicated mitral valve murmur. This result, probably means pathogenic periodontal bacteria attack and makes colonization through bacteremia.

Fig. 4

23% due to premature atrial contraction, 14% atrio-ventricular (A-V) block and 6% was caused by other abnormally ECG findings in residents of abnormal heart findings

significantly tendency by statically analyze increasing according to over 20% of BOP.

The systemic disease conditions were examined by interview method and charted by a physician. The following systemic and tropical diseases were the most common in the targeted residents : Heart Disease, Tuberculosis, Dengue Fever, Respiratory Disease, Gynecologic Disease, Malaria, Dermatologic Disease, Kidney Disease : Abnormal Uric Acid, Urologic Disease, Hypertension, HIV/AIDS, Diabetes, Schistosomiasis, Leishmania, Liver Disease, and Nervous Disorder. High blood pressure (hypertension) is the one risk factor highly related to the onset of heart disease, which indicated a very high ratio in targeted residents of almost 40%. Abnormal heart findings were discovered in 29% of the targeted residents. These comprised 34% mitral valve murmur, 18% tricuspid valve murmur, and 16% other abnormal heart sound (Fig. 3) . The ECG findings in the residents with abnormal heart findings revealed 23% due to premature atrial contraction, 14% atrio-ventricular (A-V) Block, and 6% was caused by other abnormal ECG findings (Fig. 4).

The residents with normal periodontal condition, wherein the periodontal PD was less than 2 mm, 23% had heart disease. The group with over 2.5 mm depth denoted a significantly increased tendency to acquire heart disease, whereas in the group with depth of over 3.5 mm, 43% had heart disease. The onset of heart disease was statistically different between over 3.5 mm group and less than 2 mm group when ana-

lyzed by t-test (Fig. 5). In spite of the heart disease was detect in no BOP group of 20%, the heart disease was significantly tendency by statically analyze increasing according to over 20% of BOP. This result strongly considered the possibility that chronic periodontal inflammation led to bacteremia and caused damages to the heart valves (Fig. 6).

Discussion

It is considered that heart disease can be caused by very complicated and multifactorial risks. Systemic inflammation is one example of a high risk factor. Periodontal disease is a severe infection characterized by chronic inflammation and bacteremia. Many papers regarding the correlation between Coronary Heart Disease (CHD) and periodontal infection has been published with different points of view. Offenbacher, S¹⁶⁾ and his group described periodontitis as a tertiary vascular infection, Lessem J¹⁷⁾ reported that the association between ischemic cardiovascular disease and periodontal infection is very dubious. Chronic periodontitis has been proposed as a potential risk factor for CHD based on many studies. In the field of "The Least Developing Country (LDC)", including the Kingdom of Cambodia, the correlation between heart disease and periodontal disease has not been reported. Even from the National Health Survey in Cambodia (1998 and 1999), there is no evidence about the actual condition of periodontal disease, as well as the onset rate of

Fig. 5

Correlation between Periodontal pocket and heart disease

23% of normal periodontal condition group who had under 2 mm PD was detected the heart disease. Over 2.5 mm periodontal pocket group was shown a significantly increasing tendency and over 3.5 mm periodontal pocket group was detected the heart disease on 43%.

heart disease. However, there are few reports in the Kingdom of Cambodia regarding the condition of heart disease, Morestin. S et al.¹⁸⁾ reported the results of 17 months' of surgical experience in the Cardio logical Centre of Phnom-Penh. Yet, this report did not refer to an epidemiologic survey. The occurrence of heart disease in the LDC laminated several factors, such as lifestyle, nutrition, living environment, and infection. Smoking is the typical aspect of a lifestyle to attack heart problems but the number of smokers in LDC is very low because of the high price of cigarettes. Poor living environment is a stronger risk factor to the development of heart disease rather than smoking because of the effects of malnutrition, unsafe water, and predisposition to infection. Poor living environments in our targeted area were investigated by our original charting method. The risk factors of living environment concerning to the onset of heart disease in particular, such as sanitary condition, unsafe water supply, and living with the livestock, make a person very prone to infection. Based on the results, all the targeted areas were unfit living environment which scored points 2 to 3. In addition, the dental IQ level and brushing behavior were also very poor.

Plaque-induced periodontal inflammation was evaluated by Plaque Control Record (PCR). The re-

Fig. 6

Correlation between BOP and heart disease

In spite of the heart disease was detect in no BOP group of 20%, the heart disease was significantly tendency increasing according to over 20% of BOP. This result is strongly considered that the periodontal chronic inflammation has caused damages to each heart valves that is influenced by Bacteremia.

sult of PCR showed the level between 60% to over 80 % in each province. This result probably correlated closely with poor dental IQ and brushing habit. It appeared that poor oral health according to PCR result was reflected in the result of pocket depth average. The average of pocket depth in each province was not so severe except in the subjects with severe periodontal infection. Conversely, BOP, which reflects the level of inflammation in the bottom of the pocket, was covered a wide range on dentition that resulted to scattering of BOP level from 25% to over 40%.

The evidences of the actual conditions on heart disease have not been satisfactorily investigated. Markowitz M¹⁹⁾ described rheumatic fever in developing countries. According to this report, rheumatic fever no longer posed as a significant health problem in socio-economically advanced countries, but it still causes 25% to 40% of all cardiovascular diseases in the rest of the world, including tropical countries, where it was once believed to be rare. Other reports also suggested the high prevalence of heart disease in LDC, yet only few epidemiologic studies could support the theory. In our project, heart disease was detected by the presence of heart murmur and abnormal ECG findings. In the result, heart murmur was discovered in 29% of targeted residents and 43% with abnormal ECG findings. Assantachai P. et al.²⁰⁾

reported about ECG survey of elderly Thai people in the rural community. The prevalence on ECG of ischemic heart disease, atrial fibrillation, left axis deviation, and conduction defect was 5.5%, 2.2%, 2.5%, and 3.1%, respectively. However, our received data indicated a higher value of abnormal ECG findings in various age distributions.

Regarding correlation between heart disease and periodontal inflammation, there are lots of studies published a lot. Tamaki Y. et al.²¹⁾ demonstrated the correlation between oral health and ECG abnormalities in Japanese subjects. The crude odds ratio was obtained by a logistic regression analysis of age, sex, number of missing teeth and filled teeth, simplified oral hygiene index, community periodontal index, and blood analysis factors. The results implied a statistically significant correlation with the prevalence of ECG abnormalities. In like manner, the result of our received data illustrated little tendency to acquire ECG abnormalities with age. However, the result was not statistically different.

In the investigation of correlation between heart disease and periodontal inflammation, in the group with normal periodontal condition, who had less than 2 mm periodontal PD, 23% was detected with heart disease. The group with greater than 2.5 mm periodontal PD showed a significantly increased tendency to develop heart disease. Lastly, 43% of the group with over 3.5 mm periodontal PD had heart disease. Using t-test, in the comparison of the onset of heart disease between over 3.5 mm group and less than 2 mm group, the result was statistically different. In spite of the heart disease was detected in no BOP group of 20%, the heart disease was significantly tendency by statically analyze increasing according to over 20% of BOP. There is a suspected mechanism regarding the indirect influence of periodontal infection to heart damage. Wu, T. et al.²²⁾ suggested that total cholesterol, CRP, and fibrinogen are possible intermediate factors which link periodontal disease to an elevated cardiovascular risk. Additionally, the problem of poor nutrition in the rural area in LDC cannot be bypassed. Liepa GU. et al.²³⁾ and Miller M, et al.²⁴⁾ reported a correlation among CRP, chronic disease, and nutrition.

There are three evidences suggesting the possibility of the direct effect of periodontal disease to the for-

mation of atheroma. One evidence is that *Porphyromonas gingivalis* (*P. gingivalis*) was cultured from the inside of an atheroma in the carotid artery and coronary artery. Second evidence is that *P. gingivalis* could actively invade endothelial cells and fimbriae are required for the process. The organism's invasion of endothelial cells may represent another strategy utilized by this pathogen to thwart the host host's immune response. The last evidence, published by Herzberg MC, et al.²⁵⁾ is about the ability of *P. gingivalis* to aggregate on platelets and trigger cardiovascular disease. It is considered that platelet aggregation is a strong influence to thrombus formation.

A relation between periodontal disease and atherosclerosis is also a very important point of view. Beck J²⁶⁾ implied that periodontal infection causes atherosclerosis through production of macrophages during inflammation. The progression of periodontal disease has very serious systemic effects to the body. First, which is a common knowledge, is the inflammation of periodontal tissue proceeding to the destruction of alveolar bone. This situation activates the immune defense mechanism with resultant systemic oxidative changes. Another effect is bacteremia. The bacteria can easily invade blood vessels near the gingiva directly through the inside of the ulcer of the periodontal pocket. This situation leads to serious bacterial infection of the internal organs. It is thus deduced that an easily infected environment must be considered a very important risk factor. In our previous report of this project, we demonstrated the situation of the living environment as a significant influence to the cause of periodontal inflammation¹⁵⁾. Since frequent and prolonged infections continuously activate the immune system, the oxidative agents produced by the immune-competent cells also cause oxidative damage to the immune system and the human body as a whole²⁷⁻²⁹⁾. The role of free radical-mediated damage has not been previously investigated. However, in conjecture, poor living environment may hasten aging by these oxidative changes, thus predisposing to periodontal infection. The results of this study may possibility that chronic periodontal inflammation may provide the vicious cycle of recurrent or prolonged infections leading to severe oxidative changes brought about by excessive immune system function, which can hasten the aging

process. However, there is no evidence regarding our results as yet.

This result strongly considered that chronic periodontal inflammation has one of the caused damages to the heart valves and is influenced by bacteremia.

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