原 著

A Study of Risk Factors Concerned the Onset of Periodontal Infection in the Least Developed Countries : The First Report

—The Influences of the Living Environments Risk Factors
at Rural Area in Kingdom of Cambodia—

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後発開発途上国における歯周感染症の発症に関するリスク・ファクターの検討 第1報
—カンボジア王国, 村落地域における生活環境因子の影響について—

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要旨: 後発開発途上国における村落地域は, 医療供給システムがほとんど機能していないばかりか, 深刻な感染症, あるいは劣悪な生活環境にさらされている。そのような状況が歯周病の発症にどのような影響を与えているのかを検討したのが本研究の目的である。本研究は 2003 年度から 2004 年度にかけて, JICA (国際協力機構) の市民参加協力推進事業および草の根技術支援の委託事業として歯科医学教育国際支援機構が実施した事業から, 特に典型的なカンボジアの村落地域である Stung Treng 県の二つのヘルスセンターの管轄する住民を対象に歯周感染症の発症と生活環境因子との関連を検討した。また, カンボジアの首都であり, 比較的インフラの整備が整っているプノンペン市に住む住民を比較対象とし検討した。生活環境因子は, 住居地域状況, 安全な水の供給, トイレの状況そして家畜との同居状況について聞き取り調査を行った。また, その他のリスク・ファクターとして熱帯感染症, 全身疾患の既往歴, デンタル IQ, ブラッシングの回数についても調査した。歯周診査は 4 点法によるブロービング・デプス, BOP, PCR を診査した。また, 内科医による心雑音, 肺音, 簡易心電図測定, 尿検査そして血圧測定を実施した。その結果, 生活環境因子が歯周感染症の発症に有意に関連していることが統計学的に証明され, さらにプノンペン市民との比較でもその影響が顕著であった。この結果の考察として, 劣悪な生活環境が住民の身体を酸化させ, 結果として老化を促進させ, そのことが歯周感染症を容易に発症させているものと考えられた。

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Abstract : General Principles and Objects : According to the background of the crisis in periodontal infection, it is necessary to conceptualize the risk management concerning relationship between various risk factors and systemic damages in rural areas of the least developed countries. The Organization of International Support for Dental Education (OISDE), in cooperation with Japan International Cooperation Agency (JICA), has started to implement a primary health care program focused in the prevention of systemic damages caused by periodontal infection since 2003 to stretch over one year and six months. The program has been applied to 7 provinces and 25 districts with beneficiary residents of over 1,300 according to the methodology. In this study, the targeted area was focused two typical rural health centers in Stung Treng province. The project had been implemented three times in these health centers since January 2004 to March 2005 and the number of residents who checked our examination and primary health care were 194. Sixty residents who live in the downtown of Phnom Penh city were served as control group in quite advanced living environment conditions.

The purpose of this study is to investigate the influence of risk factors associated with poor living environment to the crisis in periodontal infection in rural area in the Kingdom of Cambodia as a field study.

Methods : Basic information of all visiting residents was charted according to our original concept. Living environment (LE) risk factors were charted based on a five-grade method. The contents of LE were as follows : 1) medical supply condition which means the distance from the referred hospital including private medical clinic, health center and health post, 2) sanitary (toilet) facility, 3) provision of safe water supply, and 4) situation of living in close proximity with the livestock. Medical systemic conditions of the residents were charted by interview method into history of systemic diseases and history of tropical infections. Also, general health conditions including physical examination of the heart and lungs sound, measurement of blood pressure, urine test and simply ECG (electrocardiogram) were assessed by the physician. The dental intelligence quotient (dental IQ) concerning periodontal infection was charted by question and answer method according to a five-grade classification. The periodontal infection was evaluated by dentists using a four-point method measurement of periodontal pocket depth, bleeding on probing (BOP), and mobility of each tooth. Plaque-induced gingival inflammation was examined by plaque control record (PCR method by O'Leary), which used a staining solution. At the same time, occlusal problems caused by missing tooth/teeth, decay, and orthodontic problem were confirmed.

Results : Statistical analysis by multiple regression analysis reveals that age ; plaque accumulation status, and living environment have very significant influences to the periodontal inflammatory status. The result demonstrates the situation of the living environment as a significant influence to the cause of periodontal inflammation.

Conclusion : The poor living and unsanitary environment may provide the vicious cycle of recurrent or prolonged infections leading to severe oxidative changes caused by the hyper functioning immune system. The end result of which is a hastened aging process. Therefore, a better living environment for the rural area residents is a must in order to prevent periodontal infections, as well as infectious tropical diseases. Nihon Shishubyo Gakkai Kaishi (J Jpn Soc Periodontol) 47 : 258—268, 2005.

Key words : periodontal Infection, risk Factors, living environments, rural area, Kingdom of Cambodia

Introduction

According to many studies, periodontal disease is a very severe type of infection. It is also strongly related to systemic conditions including heart disease, ischemic stroke, respiratory disease, deterioration of diabetes, low birth weight, etc.¹⁻¹⁰⁾. A num-

ber 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⁾. Biological risk factors consist of specific bacteria, genetic traits, and systemic conditions. On the other hand, behavioral risk factors

are predicted based on the lifestyle of an individual, e.g. smoking, mental stress and poor oral hygiene. The risk factors can also be simply classified into local, host, genetic, environmental, psychosomatic, and lifestyle factors.

The crises in infectious diseases are largely influenced by the function of the host's immune system. Dengue Fever, for example, can cause infant death due to the poorly developed immune defense in such age group. In fact, in the least developed countries, tropical infectious diseases spread rapidly in the group of people with decreased resistance to infection. They are the following ; the infants, the elderly, and the immunocompromised. The decreased function of the immune system in relation to poor living environmental condition in least developed countries may contribute to the occurrence of periodontal infection. However, no evidence has been reported yet regarding the relation between poor living environmental condition and periodontal infection.

The Organization of International Support for Dental Education (OISDE), in cooperation with Japan International Cooperation Agency (JICA), has started to implement a primary health care program focused in the prevention of systemic damages caused by periodontal infection since 2003 to stretch over one year and six months. The program has been applied to 7 provinces and 25 districts with beneficiary residents of over 1,300 according to the methodology that we modified. In this study as the first report, the targeted area was focused two typical rural health centers in Stung Treng province. The project had been implemented three times in these health centers since January 2004 to March 2005 and the number of residents who checked our examination and primary health care were 194. Sixty residents who live in the downtown of Phnom Penh city were served as control group in quite advanced living environment conditions.

The purpose of the study is to investigate the influence of poor living environment to the crisis of periodontal infection in 2 rural health centers in Stung Treng province in the northeastern part of Kingdom of Cambodia as typical rural condition area and comparison with residents in Phnom Penh

city. The result demonstrates that poor living environment in the rural areas in Kingdom of Cambodia is a risk factor that contributes strongly to the crisis and progression of periodontal disease as compared with Phnom Penh city according to statistics determined by multiple regression analysis.

Materials and Methods

Target area :

The areas of study included Preah Romkel Health Center and Kamphon Health Center in Stung Treng Province in Kingdom of Cambodia. Data were shown in Table 1.

Preah Romkel Health Center is located near the border to Laos. The place can be reached via the sandbank of Mekong River, which is 1 and 1/2 hours by speedboat from the city of Stung Treng. The health center is under the administration of Thala Bariwat District. It covers a population of 6,128 residents. However, half of covered population takes over one hour by walk reach to the health center. The main source of livelihood is farming and fishing. A third of the population originates from the Lao race, thus, has its own dialect but the Khmer language is understood by the majority. The district has 2 primary schools but no junior high school and higher educational institutions. Poor environmental condition in the area is influenced by poor sanitation as seen by improper toilet facilities, inadequate supply of safe water, and living in close proximity with the livestock. The area is endemic to malaria, dengue fever, acute diarrhea, typhus, tuberculosis and other tropical diseases. Non-government organizations' activities that promote health care have not yet been implemented.

Kamphon Health Center is also located near the Mekong River. It is 35 km away from Stung Treng city and it takes 1 hour by car to reach the place. The covered population is 7,511 residents, majority are farmers. Many minority races, including Lao, live around the area of the health center. Each race speaks its own dialect and only few can understand Khmer. Communication is therefore difficult as compared to the situation in Preah Romkel health center. From the mid-1990, the NGO has constructed wells that provide the

Table 1 Outline of Stung Treng province

Population	80,208			
Administrative Districts	5			
Communes	34			
Villages	128			
Medical institution				
Operational Districts	1			
Referral Hospital	1			
Health Centers	10			
Covered by Administrative Districts				
Name of districts	Population	Communes	Villages	
Stung Treng	21,134	4	17	
Thaia Bariwatt	21,444	11	44	
Siem Pang	13,474	5	28	
Sesan	11,109	7	22	
Siem Bok	10,047	7	17	
Total	80,208	34	128	

source of water in the area, thus, living environment is comparatively good. However, health care programs are not well maintained, so the dilemma on tropical infections is similar to other rural areas in Kingdom of Cambodia.

And as a comparative subject, 60 resident who live a downtown of Phnom Penh city were examined periodontal status using probing depth and BOP reaction at the clinic of Health Science University faculty of Odontostomatology on the same method of our project.

The charted methods :

Basic individual information : Basic information of all visiting residents was charted about name, sex, birth, occupation, marriage status and number of children including infant mortality for only married female according to 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 including living place, sanitary including toilet facility, safe water supply and the condition of living in close proximity with the livestock and its concrete matters were shown on table

2. Medical systemic conditions of the residents were charted by interview method into history of systemic diseases and history of tropical infections. Also, general health conditions including physical examination of the heart and lungs sound, measurement of blood pressure, urine test and simply ECG (electrocardiogram) were assessed by the physician. 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 counted points as follows : Point 1 : Do you know the periodontal disease? (Only term) Point 2 : Do you know the symptoms of periodontal disease? Point 3 Do you know the reason of periodontal infection? Point 3 : Do you know the dental plaque or calculus? And totally counted points were classified five grades that grade 1 is 9 points, grade 2 is 6 points, grade 3 is 3 point, grade 4 is 1 point and grade 5 is counted 0 point that means all incorrect. As a behavior risk factor for the periodontal inflammation was evaluated the times of tooth brushing using by interview method for all residents. The tooth brushing usage was also evaluated as be-

Table 2-1 The risk evaluation of living environment applied by the five-grade system

The regional environment risk			The water supply conditions risk		
Grade of Risk	Living place	Check	Grade of Risk	Conditions of water supply	Check
1	In the city		1	Available a Public water service	
2	Suburb of city (within 5 km)		2	Available a water from a well	
3	In the village		3	Available a water from collected rainwater	
4	Outside of village but within the range (within 10 km)		4	Use water from river or marsh	
5	Outside of village (takes over one hour using any transportation)		5	Use water from drain water	

Table 2-2 The risk of toilet conditions and live with livestock

Grade of Risk	Toilet conditions	Check	Grade of risk	Condition with livestock	Check
1	Toilet with inside own house used an earthenware pipe		1	No livestock	
2	Toilet with outside house (shed type) and used an earthenware pipe		2	Living with livestock but different place (different area with house)	
3	Toilet with outside house (shed type) but it is not used an earthenware pipe or use public toilet with community		3	Living with livestock but different place (same area with house)	
4	No toilet but excreta treats at different place with livestock		4	Living with livestock in same house but different space	
5	No toilet but excreta treats same place with livestock		5	Living with livestock in same house and space	

havioral risk factor by five-points method according 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 :

The periodontal infection was evaluated by a four-point method measurement of periodontal pocket depth. Active inflammatory periodontal pocket was examined by bleeding on probing (BOP), and mobility of each tooth. Plaque-induced gingival inflammation was evaluated by plaque control record (PCR method by O'Leary), which used a staining solution. At the same time, occlusal problems caused by missing tooth/teeth, decay, and orthodontic problem were confirmed

The prevention and enlightenment programs :

For the purpose of preventing, all visiting residents at the health center were informed the sys-

temic damages cause by periodontal infection according to the original program.

The primary health care :

For the primary health care, scaling was done for each resident using ultrasonic scalar and hand scalar as needed for the periodontal disease condition.

Results

The project in Stung Treng province had been implemented three times and covered a total of 194 residents who visited both health centers. Residents below 18 years old were not included as subjects because the focus was on adult periodontitis. The distribution of sex showed 80 males and 114 females, while age distribution was illustrated in figure 1. Living environment risk factor in targeted area was evaluated based on 4 items. The

consideration of living place that concerned the distance from medical supply installations were indicated in-between point 3 or 4. The safe water supply condition was approximately point 2 because these health centers are located beside of Mekong River because it is easy to provide water, and also a well is provided each small commune that consist 4 or 5 families. The average rate of safe water supply condition in whole of Kingdom of Cambodia is approximately 30% in 2002 dated. However, the rate of safety water supply indicated over 50% in the area covered by these health centers. It is much better safe water supply condition comparison with other rural area in Kingdom of Cambodia. The average rate of sanitary facilities condition including toilet facility in these health centers was approximately 18%. The average of sanitary facilities condition in whole of Kingdom of Cambodia except Phnom Penh city is also 18% that dated 2002. It was almost same rate on the average of whole of Cambodia. Close live with livestock is one of severe risk factors concerned with the cause of SARS (Severe Acute Respiratory Syndrome) or other anthroponosis. Approximately 80% of residents who visited in these health centers raised livestock in their own house and all of residents who raised livestock were live with same space. However, the actual data of close live with livestock have not described regarding the risk of anthroponosis (Fig. 2). The systemic condition was evaluated into two items ; general systemic condi-

Fig. 1 The age distributions on male and female in each health center at Stung Treng province

tion and history of tropical infections. Malaria is a most common tropical infection disease in Kingdom of Cambodia and 31.7% residents were infected by Malaria on both health centers. 28.5% residents were indicated abnormally heart sound or ECG observation. Apparent of other systemic disease were recognized hypertension, respiratory diseases, tuberculosis and acute diarrhea/dysentery in these health centers. The questionnaire regarding periodontal infection was assessed by "Q & A" method. The result showed 98.43% of the residents did not understand the meaning of periodontal disease and 65.62% did not even know the term periodontal disease.

Regarding behavioral risk factors, the use of toothbrush was a very important point of view. The results revealed that 78.12% of residents brushed their teeth once or twice a day, however, 15.62% did not use a toothbrush. Smoking was investigated on all residents as a behavioral risk factor. Only two male residents were discovered as smokers because it is very difficult to buy cigarette for their economical condition. Meanwhile, the habit of betel nut chewing was detected in three elderly female residents. The periodontal inflammatory condition measured by periodontal pocket depth was clearly evident in residents with smoking and betel nut chewing habits. Oral hygiene as a

Fig. 2 In comparison with Stung Treng province and Phnom Penh city about living environment conditions, it indicated its clearly different between each places especially sanitary facility and live with livestock

behavioral risk factor was assessed by plaque control record (PCR). A PCR value of 75—100% was indicated as risk grade 3-4 based on the classification. The result of the PCR value revealed 79.68% of the residents were detected as risk grade three or four. Reaction of active and pathologic pocket on Bleeding On Probing (BOP) was evident. Over 50% BOP reaction was detected on 53.12% residents. Pocket depth was also measured by four-point method for each remained teeth. The result showed the average of pocket depth was 2.96 mm and approximately 11% residents with an average of over 3.5 mm pocket depths indicating a very severe periodontal inflammation. Meanwhile the residents in Phnom Penh city indicated 2.3 mm average of pocket depth and approximately 5% residents with an average of 3.5 mm deep pocket. Also BOP rate was compared between ST and Phnom Penh city. The BOP rate in ST was indicated approximately 50% on the average of all residents however Phnom Penh city was indicated approximately 29%. Accordingly the pocket depth and BOP rate were compared between residents in Stung Treng and Phnom Penh city with aging distribution using by t-test statistical analysis. In the result, it was recognized significant difference between both places (Fig. 3). Furthermore, for more detail periodontal inflammation statuses were evaluated on the total of periodontal depth and BOP rate. In Stung Treng province, residents less than 20 years old were in-

dicated on 29.1 points but same age of Phnom Penh city residents were only 5.1 points. And over 20 years old residents in Stung Treng residents were indicated over 40 point and this point had showed a tendency to increase according to aging. The statically analyzed for this tendency was implemented using by t-test statically, it was significantly difference between Stung Treng province and Phnom Penh city (Fig. 4). The result measured up to evidence based expectations. Statistical analysis of the results by multiple regression

Comparison with PD and BOP between PNH and ST

Fig. 3 In comparison with Stung Treng and Phnom Penh city about average of PD and BOP, it demonstrated statistically significantly difference on BOP level between each places

Age distribution of BOP comparason between ST and PNH

Fig. 4 In comparison age distribution of BOP level between Stung Treng and Phnom Penh, this distribution indicated statistically significantly difference between each places from aged 20 to 44

analysis reveals that age ; plaque accumulation status and living environment have very significant influence to the periodontal inflammatory status. Accordingly, because age and plaque accumulation status are well-known causes of periodontal disease, evaluation by multiple regression analysis only included living environment in the reevaluation. The result demonstrates the situation of the living environment as a significant influence to the cause of periodontal inflammation (Fig. 5).

Discussion

An epidemiological study for periodontal disease has been analyzed by several viewpoints. CPITN has been a frequently used index in such study. It has been originally designed to describe treatment needs in populations. For this purpose, only the worst periodontal condition around each index tooth is recorded. Such a recording procedure can be regarded as a hierarchical scoring method¹⁵⁾. It carries out its mission to assess the distribution of treatment needs for a large number of populations. However, in the assessment of small number of population with specific tendency, it does not bring its ability into full play because of its original method. For the concept of our study, it is necessary to analyze the relationship between more detailed individual physical condition and periodontal status in rural area residents, which is basically the principle in periodontal medicine. Therefore, our study has analyzed periodontal probing for all teeth utilizing a four-point method, which is different from CPITN. The concept of periodontal medicine has been disseminated to people of medical/dental-practice as a worldwide consensus for the past decades and half years through the enormous academic papers, coverage or enlightenment projects. However, despite the fact that systemic conditions have been aggravated by periodontal infection, only few people become conscious of this fact. Ordinary people, mass media and even those concerned with medical or dental practice remain unperturbed.

Reports regarding risk factors for periodontal disease have been published. Genco, R. J. has referred in his textbook¹⁶⁾ the classification of risk

Fig. 5 The result of the relation ship between active periodontal inflammation (average of pocket depth) applied by Multiple Regression Analysis This Diagram shows the strong correlation between living environment and active periodontal inflammation

factors for the crisis in periodontal disease as the following ; background or determinants, systemic, immune defense-related, stress or psychological, medications, dietary, genetic and local risk factors. For example, background factors or determinants refer to age¹⁷⁾, race and gender¹⁸⁾. Tobacco use and diabetes mellitus are classified as systemic factors^{19,20)}. Sometimes, mental stress or psychological disorders also bear a major influence²¹⁾. Meanwhile, periodontal disease contributes hugely to the aggravation of heart disease, respiratory disease, diabetes, ischemic stroke, low birth weight and other serious systemic diseases according to many evidenced-based studies²²⁻²⁴⁾. The progression of periodontal disease has 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. In bacteremia 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. The poor living environment in the rural area in least developed countries mediates between microorganisms and infectious diseases such as malaria, dengue fever,

tuberculosis, HIV infection, acute diarrhea, etc. The most serious problems associated with poor living environment are inadequate supply of safe water, improper toilet facility and the risk of living in proximity with the livestock. In our study, the influences of poor living environment have contributed to the crisis of periodontal disease and its progression. A large number of reports have been published regarding the occurrence of periodontal or gingival disease in the rural area²⁵⁻²⁹. Miyazaki H reported about Kingdom of Cambodian periodontal status using CPITN method³⁰. According to this paper, the periodontal status of Cambodians increases with age as indicated by both CPI and LA (Loss of Attachment). Calculus is the most common finding among Cambodians pointing to overall poor oral hygiene. Notwithstanding the poor oral hygiene, the severe periodontitis as denoted by ≥ 6 mm periodontal pockets is rare even in the elderly, while edentulousness is not frequently observed until 65 years. However, this report does not mention the influences of poor living environment. It is basically a similar scenario wherein a poor living environment causes either infectious tropical diseases or periodontal infections. In order to demonstrate this basic concept in our study, the relationship between periodontal inflammatory status and other risk factors are evaluated. The periodontal inflammatory status is assessed by the periodontal pocket depth and BOP reaction. The risk factors are determined by risk grade for age, living environment, systemic conditions, dental IQ, and plaque accumulation status. Especially for the purpose of crystallized the difference living environment between advanced or poor situation that compared between Stung Treng and Phnom Penh city was analyzed. In the result, residents who live poor living environment situation area was indicated clearly severe periodontal inflammation condition compared with advanced live environment area like Phnom Penh city. This result may suggest that poor living environment strongly influence to cause of onset of periodontal disease. According to this result, statistical analysis by multiple regression analysis reveals that age; plaque accumulation status and living environment have very significant influence to the periodontal

inflammatory status. Accordingly, because age and plaque accumulation status are well-known causes of periodontal disease, evaluation by multiple regression analysis only included living environment in the reevaluation. The result demonstrates the situation of the living environment as a significant influence to the cause of periodontal inflammation. 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 whole³¹⁻³³. 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 emphasize that poor living environment may provide the vicious cycle of recurrent or prolonged infections leading to severe oxidative changes brought about by excessive immune system function, which hasten the aging process. Therefore, a better living environment for the rural area residents is a must in order to prevent periodontal infections, as well as infectious tropical diseases.

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