Linking Gingivitis to Lacunar Infarction through Hemorheology in Chinese Elderly Patients

Yue JI[1]*, Yanling LI[1] and Xiaoping LIN[2]

[1]Jinqiu Hospital of Liaoning Province, Shenyang 110016, China.
[2]Shengjing Hospital of Chinese Medical University, Shenyang 110004, China.

As a common infectious disease in the elderly, gingivitis is caused by microbial plaque on tooth supporting tissues. In order to investigate whether there is a linkage between the gingivitis and hemorheology of elderly patients with lacunar infarction, 123 cases of patients were divided into two groups, i.e. a severe gingivitis group (33 patients with a gingival index ≥ 2.1) and a mild gingivitis group (90 patients with a gingival index < 2.1). The hemorheological variables, i.e. whole blood viscosity, plasma viscosity, whole blood reducing viscosity, hematocrit and plasma fibrinogen of these patients were determined. The statistical T-test results showed that the plasma fibrinogen (Fib) ($P < 0.01$) and whole blood viscosity at middle shear rate (ηbM) ($P < 0.05$) of patients in the severe gingivitis group were significantly higher than that in the mild gingivitis group. This result revealed that there was a linkage between gingivitis and lacunar infarction. In addition, this study implied that gingivitis would increase the occurrence frequency of lacunar infarction in old people, and the hemorheological variables, ηbM and Fib, might be potential indicators for early diagnostics of lacunar infarction.

As a common infectious disease in the elderly, gingivitis is caused by microbial plaque on tooth supporting tissues[1,2]. Since China is entering a stage of the aging society, it is increasingly concerned with the health problems of the elderly, especially the cardiovascular and cerebrovascular diseases. In recent years, more and more evidences showed that chronic inflammation was associated with diabetes, cerebrovascular accident and other systemic diseases[3,4]. These systemic diseases are usually accompanied by changes in hemorheology. Furthermore, many studies also supported that there was a linkage between some hemorheological variables with symptomatic small-vessel diseases[5,6,7]. Recent years, some studies have suggested an association between periodontitis and ischemic stroke[8,9]. However, very few studies have been conducted on this in an elderly population in China.

In this study, 123 cases of Chinese elderly patients, suffering from both gingivitis and lacunar infarction, were selected as studying patients. According to the level of gingivitis, they were divided into two groups, namely a severe gingivitis group and a mild gingivitis group. Some hemorheological parameters of them were measured. By statistically analyzing the difference of hemorheological parameters between these two groups, the aim of this study was try to understand the impact of gingivitis on hemorheology of patients with lacunar infarction, and try to explore the relationship between gingivitis and lacunar infarction in an elderly population.

MATERIALS AND METHODS

Selection of studying patients

Based on the results of cranial computed tomography (CT) diagnosis, 123 cases of patients with lacunar infarction were selected from the population in physical examination at Jinqiu

---

* To whom all correspondence should be addressed.
Tel.: +86 024 62784567; Fax: +86 024 62784568;
E-mail: yue_ji72@hotmail.com

Hospital of Liaoning Province, China, within the period from January to December of 2008. There were 109 males and 14 females among these patients, with ages between 60 and 87. The inclusion criteria for the selection of studying patients were: 1) non-diabetes, non-nephritis, non-chronic bronchitis, non-emphysema and non-chronic gastritis; 2) do not suffer from infectious diseases during the past 30 days; 3) more than one tooth in the mouth.

Grouping patients

According to the procedure reported by Yue[10], gingivitis index (GI) of the 123 patients was measured by the same dentist (avoiding the variation in results from the different dentists). Based on the results of GI, the patients were divided into two groups, i.e. the group with a severe gingivitis (GI≥2.1,) and the group with a mild gingivitis (GI<2.1). In the severe gingivitis group, there were 33 cases (28 males and 5 females) with an average age of 76.3. While, in the mild gingivitis group, there were 90 cases (81 males and 9 females) with an average age of 78.1.

Hemorheological parameter measurement

Hemorheological parameters, such as whole blood viscosity (ηb), plasma viscosity (ηP), whole blood reducing viscosity (RV), hematocrit (HCT) and plasma fibrinogen (Fib) of venous blood from these patients were measured immediately after blood sampling. These parameters were analyzed with a U-shaped scanning capillary-tube viscometer (FASCO-3010A, Weiduo, LTD, China), except Fib. Fib was measured with an automatic biochemical analyzer (7060, Hitachi, LTD, Japan).

Statistical Analysis

Mean values and standard errors of data from the groups were calculated with Excel 2007 software. The statistical differences of parameters between two groups were tested by one-way analysis of variance (ANOVA) of SPSS 15.0 (SPSS, Chicago, USA), and P<0.05 was considered as a level of statistical significance.

RESULTS

In this study, the 123 patients were divided into two groups: the severe gingivitis group (GI≥2.1) and the mild gingivitis group (GI<2.1). There were 33 cases in the severe gingivitis group (28 males, 5 females, average age 76.3), and 90 cases in the mild gingivitis group (81 males, 9 females, average age 78.1). No significant difference of the male/female ratios or the average ages between two groups was found.

The results of hemorheological parameters, i.e. whole blood viscosity, plasma viscosity, whole blood reducing viscosity, hematocrit and plasma fibrinogen of the patients were listed in Table 1. The whole blood viscosity at middle shear rate (ηbM) in the severe gingivitis group and the mild gingivitis group were 5.47 mPa.s and 5.27 mPa·s, respectively. While, the plasma fibrinogen (Fib) was 3.38 $g·L^{-1}$ in the severe gingivitis group and 3.13 $g·L^{-1}$ in the mild gingivitis group. The T-test results showed that the plasma fibrinogen, as well as whole blood viscosity at middle shear rate (ηbM), of the severe gingivitis group were significantly higher than that in the mild gingivitis group (P < 0.05) (Table 1). No significant difference of other tested variables between two groups was found.

DISCUSSION

Lacunar infarction is one type of ischemic stroke. Although without a clinical symptom, some patients can be diagnosed as a asymptomatic

Table 1. The comparison between hemorheological variables from the severe and the middle gingivitis groups

Groups Variables	Severe gingivitis group	Middle gingivitis group	P value of T-test
ηbH ($200s^{-1}$) (mPa·s)	4.59±0.42	4.47±0.46	0.195
ηbM ($30s^{-1}$) (mPa·s)	5.47±0.41	5.27±0.52	0.048
ηbL ($3s^{-1}$) (mPa·s)	11.05±0.87	11.06±1.05	0.967
ηP (mPa·s)	1.48±0.08	1.50±0.08	0.268
HCT (%)	0.42±0.03	0.42±0.06	0.847
Fib ($g·L^{-1}$)	3.38±0.44	3.13±0.33	0.001

infarction by the cranial imaging examination. There is a higher recurrence rate of the Lacunar infarction, which could lead to multiple lesions in the brain, and the consequent dysfunction. In recent years, some studies suggested that ischemic stroke may be associated with a type of chronic oral infection - periodontal diseases. Grau et al[1] found that gingivitis independently associated with ischemic stroke risk, and severe gingivitis was an important independent risk factor. Gingivitis, through recurrent bacteremia, can promote activation of platelet and increase in clotting factors. The alterations in these parameters of hemorheology may trigger a ischemic stroke.

In order to keep the physiological function of a body, a normal hemorheological state is needed to ensure the timely supplements of oxygen and nutrients from blood perfusion to all organs and tissues. An abnormality in hemoreology, normally reflecting a altered tissue blood perfusion, would lead to a series of serious consequences, such as tissue hypoxia, metabolic disorders, dysfunction[2]. Some studies showed that bacterial infections, especially periodontal infection, would lead to changes in hemostatic variables and rheological variables, and thereafter would promote the development of cardiovascular disease[6]. In this study, it is found that, compared with that in the mild gingivitis group, a hemorheological variable (i.e. whole blood viscosity at middle shear rate, ηbM) was significantly increased in the severe gingivitis patients. This indicates that the severe gingivitis would result in some changes in hemorheology.

Fibrinogen (Fib), coagulation factor I, is synthesized by the liver and mainly present in the plasma, platelets and megakaryocytes. Fib participates in blood coagulation, platelet aggregation and fibrinolytic process. In this study, a remarkable decline of Fib concentration in patients with severe gingivitis was observed (p < 0.01). This finding is consistent with that reported by Martin et al [7] and Lowe et al [3]. The oral cavity, as a sustainable resource for bacteria, is a major site of chronic infection and inflammation, particularly periodontal disease[13]. Bacteria in gingival sulcus can enter the bloodstream when patients are chewing food or brushing teeth. This would result in a transient, repeated bacteremia, and induce the immune response from the body.

Therefore, accompanying with the elevated markers of systemic inflammation, a chronic and persistent state of infection should promote the atherosclerotic processes[4]. In addition, the most significant difference (P < 0.01) observed in plasma fibrinogen between severe and middle mild gingivitis group, implied that plasma fibrinogen might be a potential indicator for early diagnostics of lacunar infarction.

In recent years, there has been increasing interest in the "periodontal-systemic connection" between dental health parameters and the risks of cardiovascular disease, respiratory disease, diabetes mellitus, osteoporosis, and adverse pregnancy outcomes[5]. This study provides an evidence that there was a linkage between gingivitis and lacunar infarction in the Chinese elderly people, and it implied that gingivitis would increase the risk of developing a lacunar infarction. To the best of our knowledge, this is the first report on this linkage in Chinese elderly patients. However, due to complexity of the changes in hemorheological properties of blood, the relationship between gingivitis and hemorheology in patients with lacunar infarction is worth to further investigation.

ACKNOWLEDGMENTS

REFERENCES

1. Lang N P. Commentary: bacteria play a critical role in the etiology of periodontal disease. *Journal of Periodontology*, 2014; **85**(2): 211-213.
2. Adams S, Scott A, Alonso C, *et al*. Examining oral bacterial populations in health and gingivitis using 454-pyrosequencing. *IADR General Session*, San Diego, California, 2011.
3. Desvarieux M, Demmer R T, Jacobs Jr D R, *et al*. Periodontal bacteria and hypertension: the oral infections and vascular disease epidemiology study. *Journal of hypertension*, 2010; **28**(7): 1413-1421.
4. Figuero E, Sánchez-Beltrán M, Cuesta-Frechoso S, *et al*. Detection of periodontal bacteria in atheromatous plaque by nested polymerase chain reaction. *Journal of periodontology*, 2011;

82(10): 1469-1477.

5. Schneider R, Wöbker G, Willmes K, *et al*. Do different ischemic brain lesions have different hemorheological profiles? *Klinische Wochenschrift*, 1986; **64**(8): 357-361.

6. Szapary L, Horvath B, Marton Z, *et al*. Hemorheological disturbances in patients with chronic cerebrovascular diseases. *Clinical hemorheology and microcirculation*, 2004; **31**(1): 1-9.

7. Marti-Fabregas J, Valencia C, Pujol J, *et al*. Fibrinogen and the amount of leukoaraiosis in patients with symptomatic small-vessel disease. *European neurology*, 2002; **48**(4): 185-190

8. Sen S, Sumner R, Hardin J, *et al*. Periodontal disease and recurrent vascular events in stroke/transient ischemic attack patients. *Journal of stroke and cerebrovascular diseases*, 2013; **22**(8): 1420-1427.

9. Sfyroeras G S, Roussas N, Saleptsis V G, *et al*. Association between periodontal disease and stroke. *Journal of vascular surgery*, 2012; **55**(4): 1178-1184.

10. Yue Songling, *Internal Stomatology*. People's Health Publishing House, China, 1991; 254-257.

11. Grau A J, Becher H, Ziegler C M, *et al*. Periodontal disease as a risk factor for ischemic stroke. *Stroke*, 2004; **35**(2): 496-501.

12. Qin Renjia, *Hemorheology*. People's Health Publishing House, Beijing, China, 1999; 9-13.

13. Lowe G D O. Etiopathogenesis of cardiovascular disease: hemostasis, thrombosis, and vascular medicine. *Annals of periodontology*, 1998; **3**(1): 121-126.

14. Lowe G D O. Dental disease, coronary heart disease and stroke, and inflammatory markers: what are the associations, and what do they mean? *Circulation*, 2004; **109**(9): 1076-1078.

15. Proceedings of the Periodontal-Systemic Connection: a State-of-the-Science Symposium. *Ann Periodontol*. 2001;**6**: 1–231.